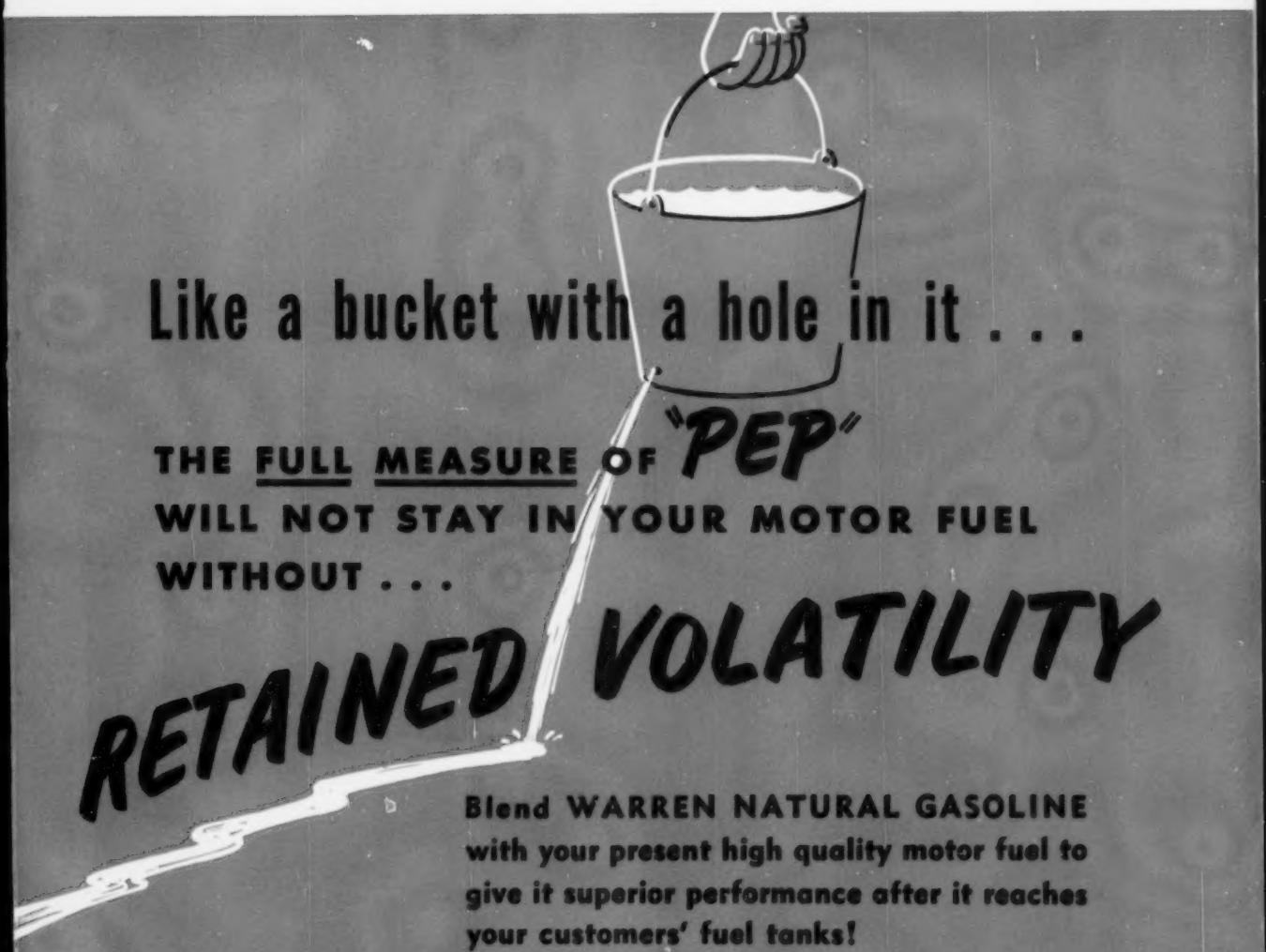
MARCH • 1956

PETROLEUM REFINER

REFINING | PETROCHEMICALS | NATURAL GASOLINE

- *Special Report on* Hydrogen Problems Page 140
- Tips on Cooling Page 181
- Watch Hydrogen Peroxide Page 197



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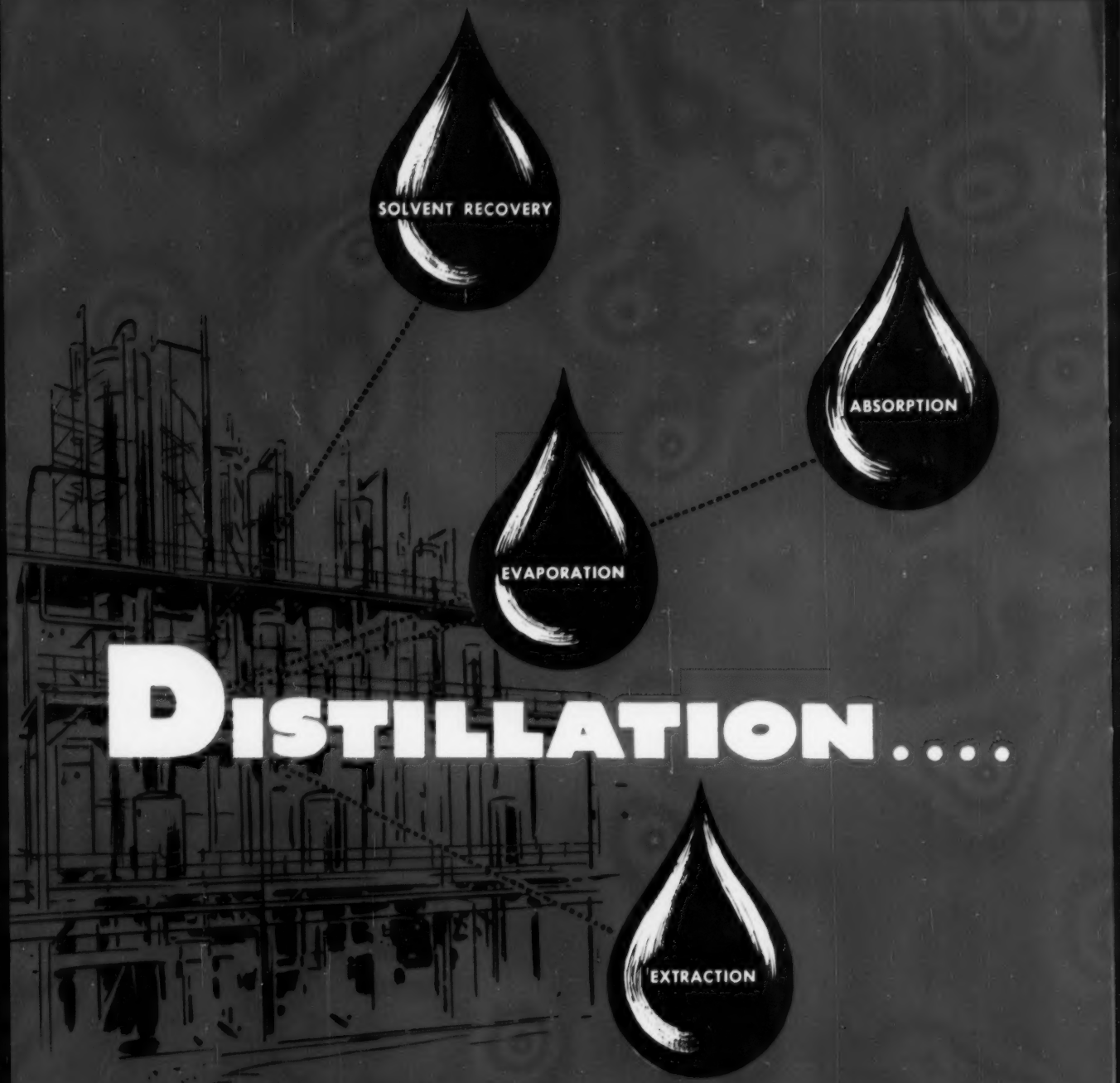

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Volume 35, No. 3 March, 1956

PETROLEUM REFINER
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A Quick Look at This Issue

These handy digests permit checking ✓ those articles you want to read first.

HOW TO COPE WITH HYDROGEN

☐ **Find Properties of Hydrogen Mixtures** . . . Do you have a problem in heat transfer or fluid flow. Is hydrogen present in the process stream? You must find the specific heat, thermal conductivity, viscosity and density of the mixture. Here are methods for determining these properties of gaseous mixtures. Turn to **Page 140.**

☐ **What Causes Hydrogen Attack?** . . . Hydrogen attack takes many forms. Some of these are more serious than others. This article will help you to recognize the various forms and plan the most economical maintenance program. Turn to **Page 155.**

☐ **What Hydrogen Does to Metals** . . . Here is what we know now about hydrogen embrittlement. The most important methods of detection are based on eight empirical observations. Preventive measures for embrittlement and attack are discussed. **Page 160.**

☐ **M-O-C for Hydrogen** . . . What alloys and steels are the most widely used in hydrogen equipment today? What are the advantages of the various alloying elements? How do these effect hydrogen decarburization, blistering and cracking? For a guide to the selection of the proper alloy, what to expect from the alloying element and the proper application of these materials turn to **Page 164.**

☐ **Fortier Plant of American Cyanamid** . . . Many factors have entered into the success of this highly integrated petrochemical plant, i.e., complete integration was achieved by selecting processes so that byproducts from one could be starting material for the other. For the complete story from plant site selection and construction to initial operation, turn to **Page 167.**

→ Now Turn the Page →

A Quick Look at This Issue

☐ **Nomograms . . . Make Your Own** . . . This is the last of a four-part series on this useful tool. This time the writer shows how to take experimental data and go directly to nomograms. Again, he uses simple examples and shows you how to make each move step-by-step. If you want to learn how to make your own nomograms, turn to **Page 171.**

☐ **Mass Spectrometer Monitoring** . . . By dialing from any public telephone, the stand-by conditions of this mass spectrometer may be determined. Since unusual conditions may be detected and corrected before the regular work day begins, more time may be devoted to sample analysis. **Page 179.**

COOLING TIPS

☐ **Air Versus Water Cooling** . . . In natural gasoline plants, the choice between these two cooling methods is no hasty decision. There are numerous installation factors which must be considered. In this article you'll find many valuable tips based on the experience of a leading designer. **Page 181.**

☐ **Computing Cooling Tower Performance** . . . Easy calculations are given for establishing cooling tower performance from routine operating data. Useful assumptions are made to simplify the computations. **Page 183.**

☐ **Revitalize Your Tower** . . . Here are some useful tips about ways to bring your old cooling tower back to life. Odds are that modernization will save you time and money. To find out how to go about it, turn to **Page 186.**

☐ **Cooling Tower Fan Gear Drives** . . . Here is information that will help solve your tower fan drive problems. Also, sound counsel is given on preventive maintenance to help you avoid trouble later. Clip this one and pass it along. Turn to **Page 189.**

☐ **Simplify Gas Cooling Design** . . . Here is an excellent method for making gas cooling tower calculations. When the limitations of the method are observed, the accuracy is sufficient for most engineering purposes. A quick analytical approximation also is described. **Page 191.**

☐ **Hydrogen Peroxide** . . . Here is a look into the future of this promising compound. For the complete story on the newest petrochemical, its production, reactions and uses turn to **Page 197.**

☐ **Designing an Electric Power System** . . . Here is the story on the Stanovan Refinery electrical power system design. This plant has all major electric drive. The background and all the details are covered. Keep up to date on current design practice by turning to **Page 201.**

☐ **Depolymerize Butene Trimers** . . . Usually the higher boiling materials are undesirable products of catalytic polymerization. This article tells how trimers may be depolymerized to dimers and monomers. To learn the conditions and the catalyst used for the depolymerization, turn to **Page 205.**

☐ **How to Select and Install Pump Seals** . . . To get trouble free mechanical seal performance you must understand fully the basic principles behind them. Here is a complete review of these principles and tips on how to sidestep future troubles. Every operations and maintenance man needs this background. Refresh your seal knowledge by turning to **Page 207.**

☐ **Low Cost Water Effluent Separator** . . . Here's a new approach to waste disposal. The article shows how one refinery beat the high cost of a secondary effluent separator. Installation cost about one fourth that of a typical concrete separator. **Page 211.**

☐ **Need More Data on H_2S?** . . . When working on absorption and stripping processes for H_2S removal, you'll find this data essential. Vaporization equilibrium constants are presented over the temperature range of —76.4 to 212.7 F and up to pressures of 1000 psia, both in tabular and graphical form. **Page 213.**

☐ **Save Tanks with Cathodic Protection** . . . Here is a comprehensive review of ways you can protect your tanks and underground piping against corrosion. Take a look to see if there isn't a way you can save some money and trouble in your plant. Turn to **Page 216.**

☐ **Mitigating Gasoline Plant Corrosion** . . . Here's the story on Tide Water's gains in applying corrosion control methods from the well to finished product storage. You can do many of these same things in your plant and save money. To learn what you can do and what you can gain turn to **Page 218.**

☐ **How Maintenance Costs Can Be Controlled** . . . Here is the story on Atlantic Refining Company's five-year improvement program. You can learn what was done and how it worked out. The improvements are outstanding and there is much that you can adapt to your own problems. Take advantage of this experience by turning to **Page 221.**

☐ **How a Rigging Sequence Is Planned** . . . Here is a highly successful rigging technique for the erection of TCC units. All the problems from field checking and engineering coordination to selection of equipment are covered in detail. Learn how use of this method can save you erection time. **Page 227.**

☐ **Employing the College Graduate** . . . Do your college interview methods meet the "ideal" standards of placement directors? Is your interviewing program "up to date" compared to other companies? The answers to these and other major college interview problems are discussed in the comprehensive PETROLEUM REFINER survey report on **Page 136.**

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PETROLEUM REFINER and The REFINERY CATALOG for the refining-natural gasoline-petrochemical industry

WORLD OIL (formerly The Oil Weekly) and The COMPOSITE CATALOG for the drilling-producing industry

PIPE LINE INDUSTRY for the oil and gas pipe line industry

Petroleum Refiner Is Indexed by Industrial Arts Index, Chemical Abstracts and by Engineering Index, Inc. Microfilm copies available through University Microfilms, An Arbor, Michigan.

Help on Hydrogen

YOU CAN'T GET away from hydrogen problems these days, can you? Not as long as the octane race forces operators to put in more catalytic reformers. We've been following your problems with this gas and have come up with a lot of job-help in this month's special report. You'll find the answers to process design calculations, especially fluid flow and heat transfer. No need to thumb through handbooks and the literature for process design—the charts in this report will do the job for you. What's more the report tells you how to recognize hydrogen attack, once the equipment is installed. Starts on Page 140.

It's Nearly April—

PETROLEUM REFINER's Natural Gasoline Special Issue is carded for April and a treat is in store. Recently one of our editors memoed that a big company representative "volunteered that PR has the best coverage of natural gasoline subjects of any of the technical magazines. The articles on absorption and stripping design and those on gas analysis must have hit him at just the right time." Our April issue will give further substantiation of this man's findings.

Timely Aid—and Free!

OUR REVISED Author's Handbook is getting wide attention, several thousand copies already having been distributed.

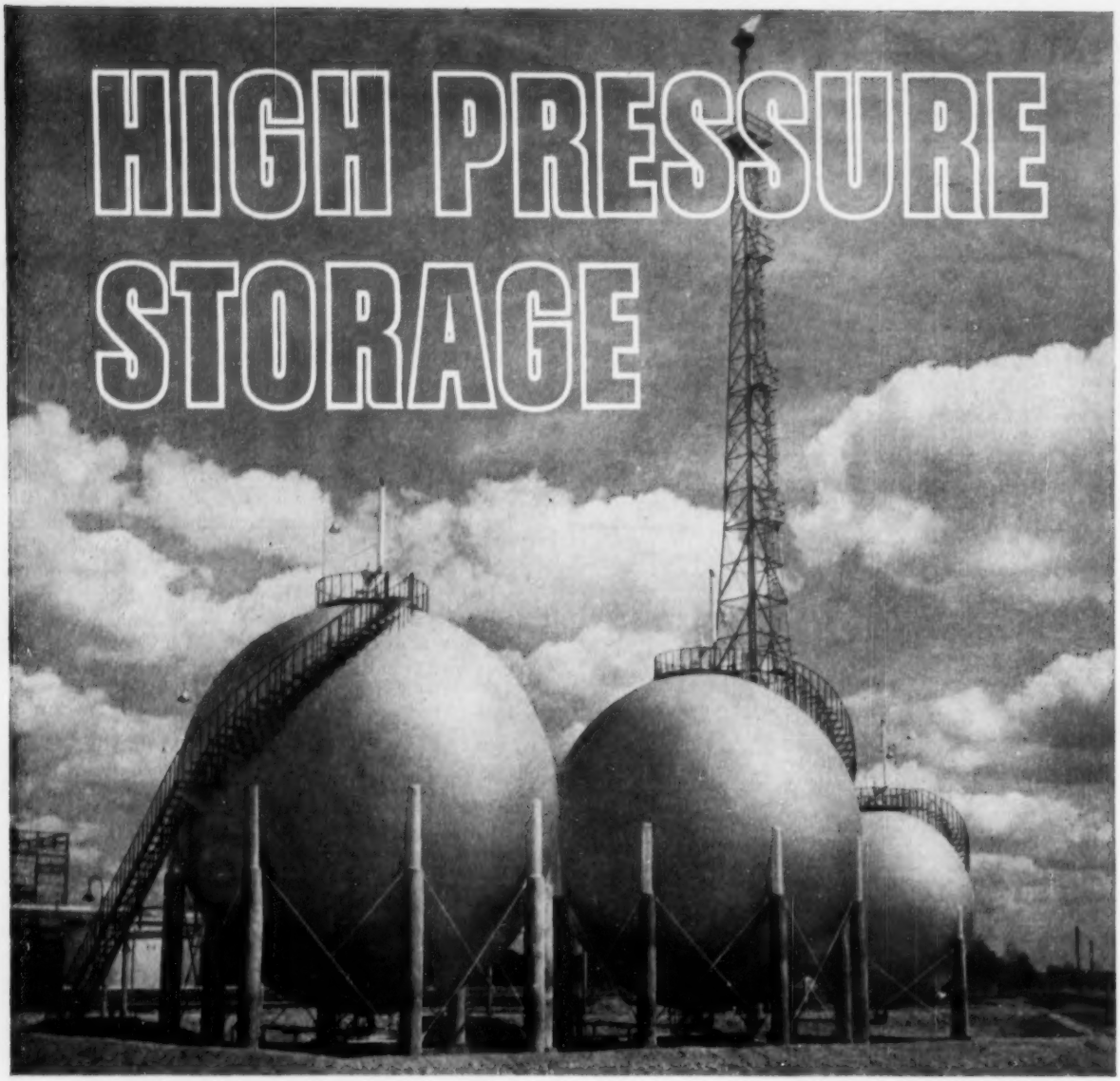
"We have indeed found the Handbook most interesting and would like two additional copies," writes the Chemicals Department of The Quaker Oats Company, Chicago. "We would like to distribute these additional copies to our laboratory for the men who are constantly writing our project reports as well as papers for publication."

Dudley T. Ross, publicity editor, Kaiser Aluminum & Chemical Corporation, Oakland, Calif., called the booklet "one of the best things of its kind that I have ever seen." He even asked for a half dozen more copies "for use in helping to educate some of our people along these lines."

If you haven't your copy just address PR's Editorial Director, PR, Box 2608, Houston 1, Texas.

Top Rating Items

A SURVEY of the reading interests of a good portion of PETROLEUM REFINER subscribers showed extraordinarily high interest in the feature "Quick Look at the Industry." This confirms our pre-publication judgment that carefully selected and succinctly presented, these items each month would have great reader appeal. Turn to page 125 and let us have your verdict. (We say "turn" and we don't mean that exactly because we wouldn't want you to pass up the 120 intervening pages of advertising. These pages offer material that is both interesting and valuable; so they carry our high recommendation too.)



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For more data on advertised products, use Readers' Service Cards, last page.

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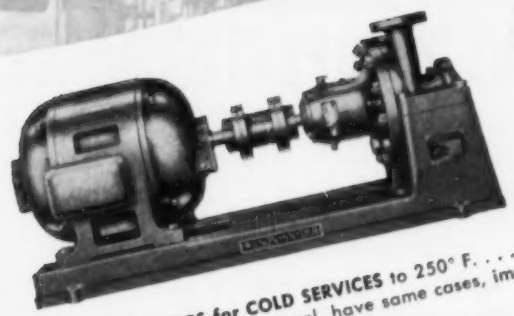

TYPE ESC PUMPS for COLD SERVICES to 250° F. . . . with built-in mechanical seal, have same cases, impellers and wear rings as Type ES.

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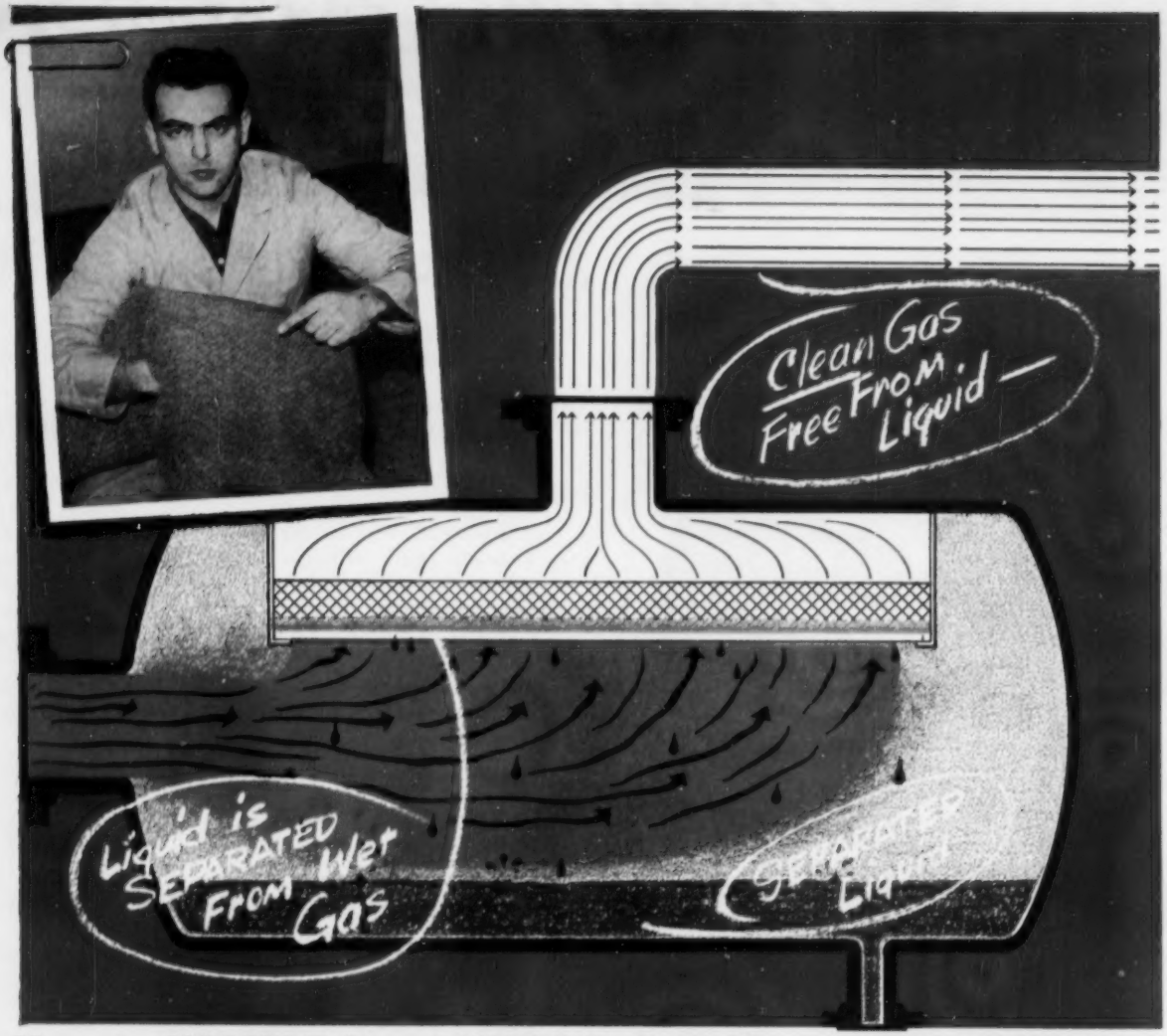

How to INSURE Good KNOCK-OUT Drum PERFORMANCE

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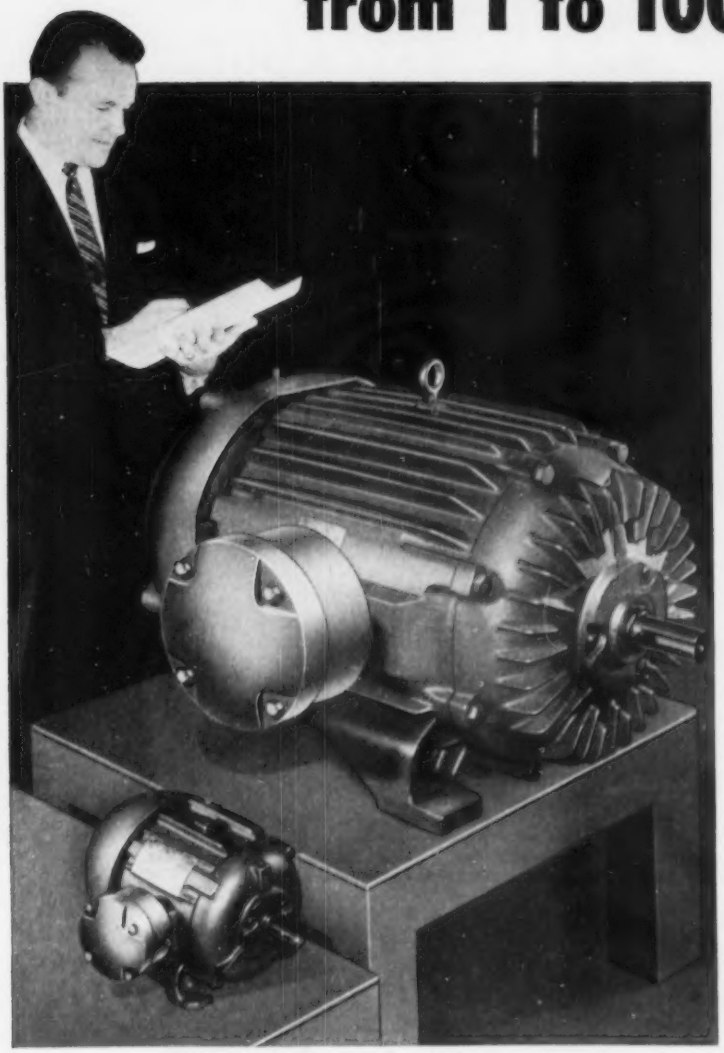
Allis-Chalmers Offers Complete Line of Rib-Type MOTORS from 1 to 100 Hp



Allis-Chalmers, a pioneer in rib-type TEFC motor design, is the only leading manufacturer offering a complete line of these motors from 1 to 100 hp. The many cost-saving features of deep-rib construction can be applied in a variety of uses... both indoors and out.

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ALLIS-CHALMERS

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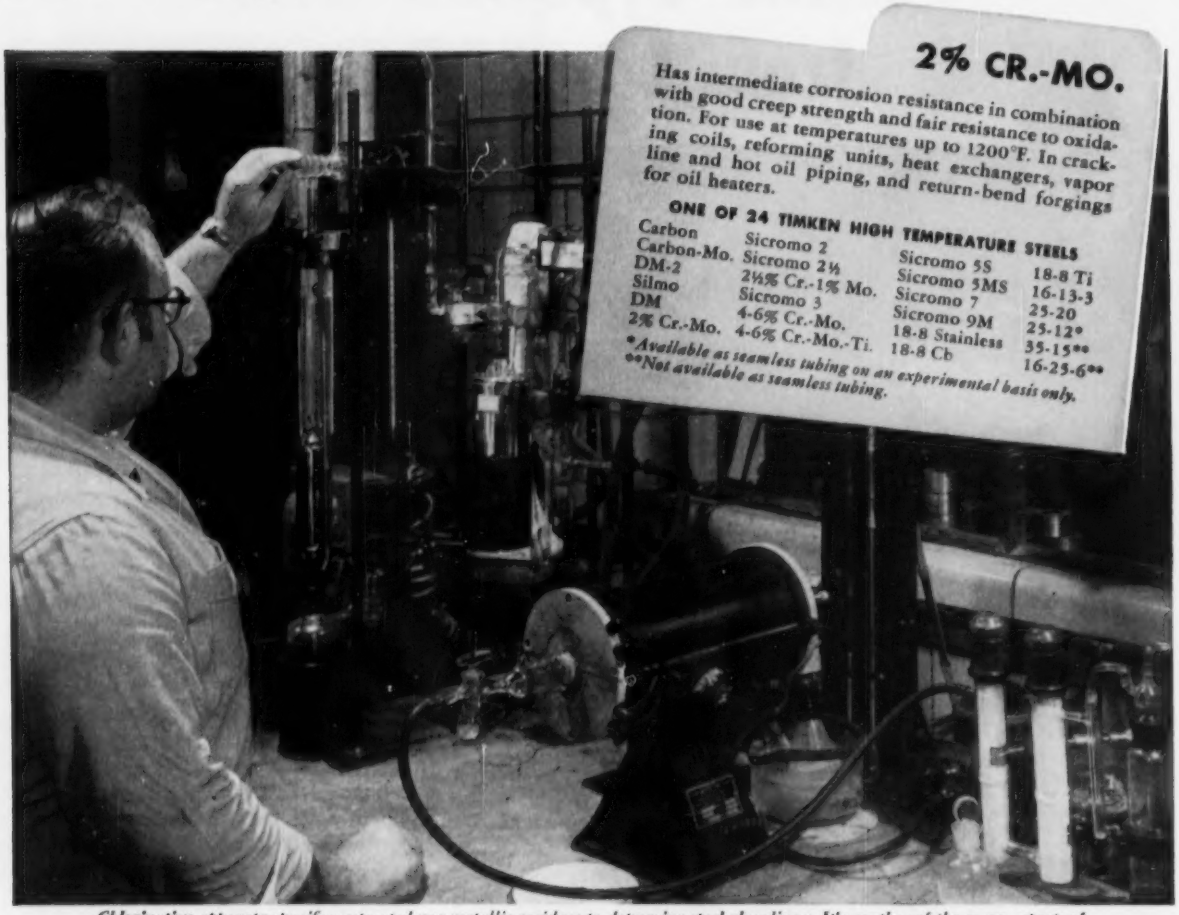
To find that one steel, *ask the experts!* Ask the Timken Company metallurgists, recognized authorities on high temperature steel tubing. When you consult these experts, you get the benefit of over twenty years' experience with high temperature steels. From the wide range of Timken® fine alloy steels, they can help you select the one that is best for your requirements. And whatever analysis you choose, you'll be assured of uniform high quality. The quality of Timken steels is controlled from melt shop through to the final inspection with the most exacting methods.

Let Timken Company metallurgists help you solve your tubing problems. *Ask the experts!* The Timken Roller Bearing Company, Steel and Tube Division, Canton 6, Ohio. Cable address: "TIMROSCO".



Chlorination apparatus purifies extracted non-metallic residues to determine steel cleanliness. It's another of the many aspects of high temperature steel research in constant progress at the Timken Company.

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SPECIALISTS IN FINE ALLOY STEELS, GRAPHITIC TOOL STEELS AND SEAMLESS TUBING

For Positive All-Weather Protection

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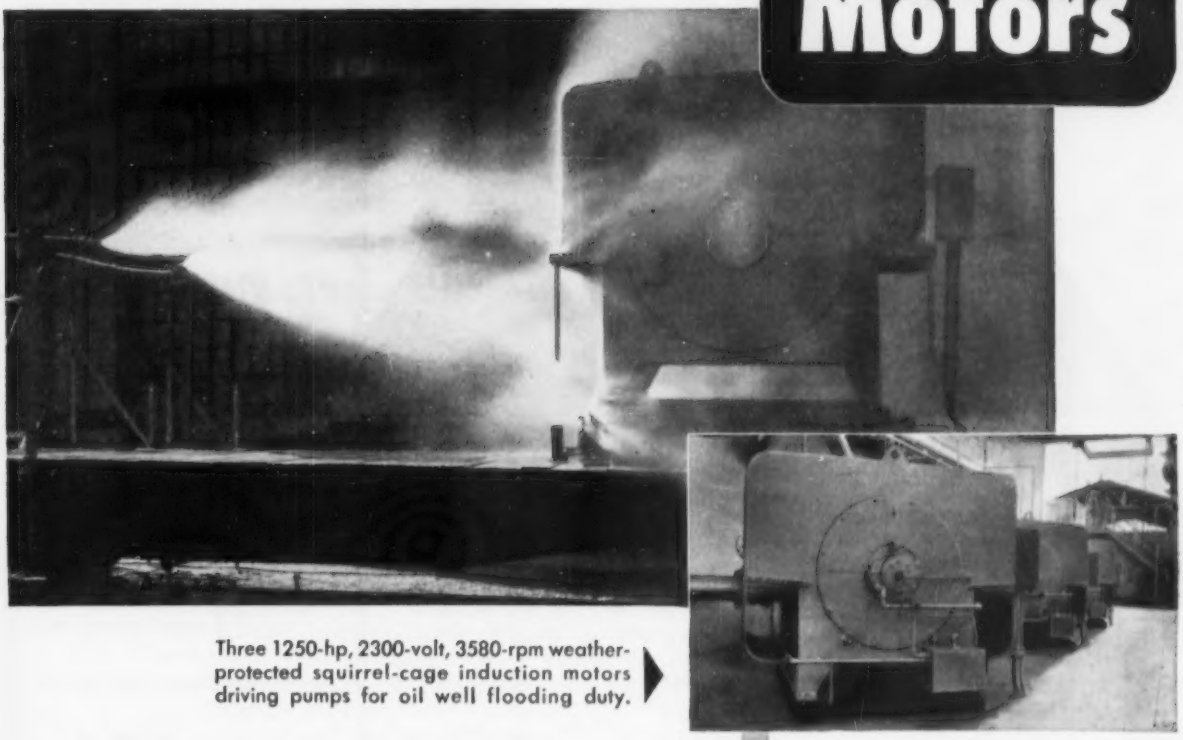
ALLIS-CHALMERS Motors



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For more data on advertised products, use Readers' Service Cards, last page.

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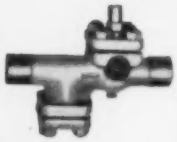
For *heavy loads* requiring extra high capacity steam traps.

INTEGRAL-STRAINER HIGH PRESSURE TRAP



For *high pressures, high temperatures.* (Flanged or welding connections.)

YARWAY IMPULSE® STEAM TRAP

OVER 1,000,000 YARWAY IMPULSE STEAM TRAPS USED

For more data on advertised products, use Readers' Service Cards, last page.

Call on ALLIS-CHALMERS for Water Conditioning

How Zeolite System at Public Service Company of Colorado

"Irons Out"

Water Irregularities Caused by Fluctuating Loads

DENVER'S UNUSUAL CLIMATE causes unusual water conditioning problems at Public Service Company of Colorado's Zuni Station. Steam from this station is used to heat downtown Denver buildings. Denver's balmy midday climate — except in the two cold months of the year—is the cause of troublesome load fluctuations.

The lime-soda-phosphate system installed in this plant by Allis-Chalmers in 1949 was one of the most modern in the country at the time. It is ideal for extremely high loads in the morning and evening, but requires careful adjustment to handle the low loads around noon.

Public Service of Colorado has decided to modernize to take advantage of developments in "hot lime-hot zeolite" systems since the original installation. The zeolite part of the system acts as its own corrective when loads drop, "ironing out" hardness irregularities in the lime effluent and eliminating need for manual adjustments. The new system will provide more consistent operation and lower hardness. The only chemicals needed are lime and salt, holding operating costs to a minimum.

The changeover, being handled completely by Allis-Chalmers, consists of adding zeolite softeners to the original equipment furnished by A-C.

Next time you have a water problem — or want to consider modernization — take advantage of Allis-Chalmers water conditioning experience. For information, call the A-C office nearest you or write Allis-Chalmers, Power Equipment Division, Milwaukee 1, Wisconsin.

ALLIS-CHALMERS

WATER CONDITIONING—CHEMICALS, EQUIPMENT, SERVICE—FOR OVER 25 YEARS

A-C ALLIS-CHALMERS

A-4846

Bingham STUFFINGBOXLESS PUMPS

HANDLE AT HIGH

FIREPROOF AND EXPLOSION-PROOF! Leakage of vapor or liquid to atmosphere or leakage from outside into pump is *impossible*. Not only is plant and personnel protected, but loss of valuable pumpage is prevented. Type KC High-Pressure Single-Stage Stuffingboxless Pump illustrated.

NO STUFFING BOX! NO PACKING!

Bingham Stuffingboxless Pumps are successfully handling liquids having high vapor pressure, requiring high suction pressure and, frequently, abnormally low pumping temperature (—300° F). Standard models handle suction pressures up to 2,000 psi (higher pressures available). Pumping temperatures to 850° F and higher also can be handled. These conditions present no difficulty for Bingham Stuffingboxless Pumps, but they are difficult and sometimes impossible to meet with conventional pumps due to limitations imposed by the stuffing box.

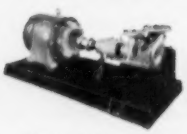
Because there is *no stuffing box*, Bingham Stuffingboxless Pumps eliminate all the disadvantages of conventional pumps operating with stuffing boxes equipped with packing or mechanical seals.

Bingham Stuffingboxless Pumps are in service today all over the world, with distinguished records in reliability, continuity of service, and low maintenance. Write to your nearest Bingham office for Bulletin 107 or for additional information.

***And other volatile liquids.**

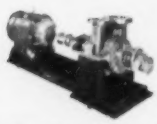
TYPICAL BINGHAM "DOUBLE VOLUTE"

The Bingham Type HPD "Double Volute" Multi-Stage Double Case "Hi-Press" pump for extremely high pressure service.



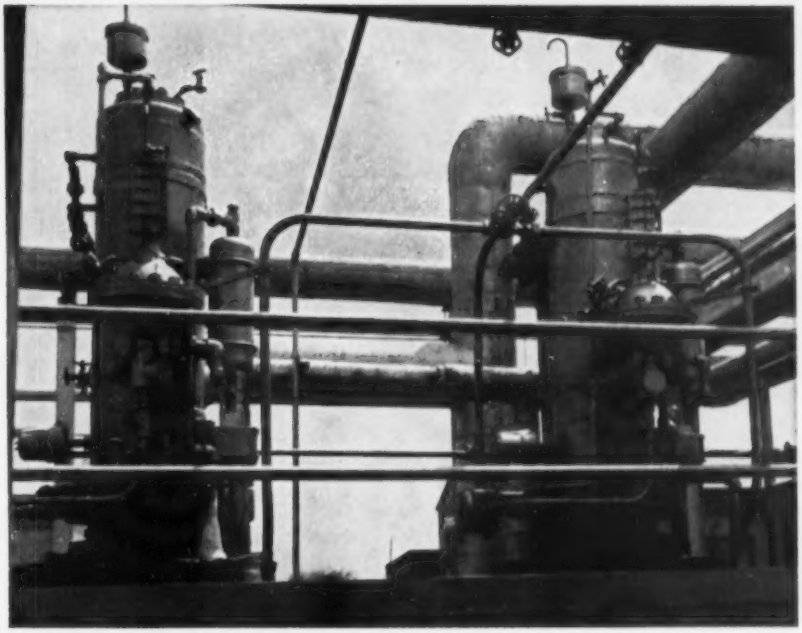
Bingham Type CAD "Double Volute" Single-Stage Process Pump.

Bingham Type CJ "Double Volute" Two-Stage Process Pump.



Bingham Type CD "Double Volute" Double Suction vertically-split case pump for hot service.

LIGHT HYDROCARBONS* SUCTION PRESSURES



Battery of Bingham Stuffingboxless Pumps handling light hydrocarbon at low temperature, under high suction pressure. Tennessee Gas Transmission Co. plant, Gabe, Kentucky.

Bingham SINCE 1921

DOUBLE VOLUTE PUMPS RADIAL BALANCE

BINGHAM PUMP COMPANY

General Offices: **2800 N.W. Front Avenue, Portland 10, Oregon**

Factories: **Portland, Ore. • Vancouver, B.C., Canada**

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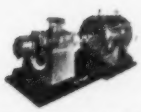
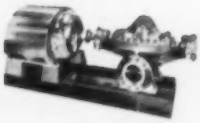
PUMPS FOR PETROCHEMICAL SERVICE



Bingham Type CM "Double Volute" vertically split case two-stage pump for hot service.

A Bingham Type CKA "Double Volute" Single Stage Koke-Krusher for coke-laden pumpage.

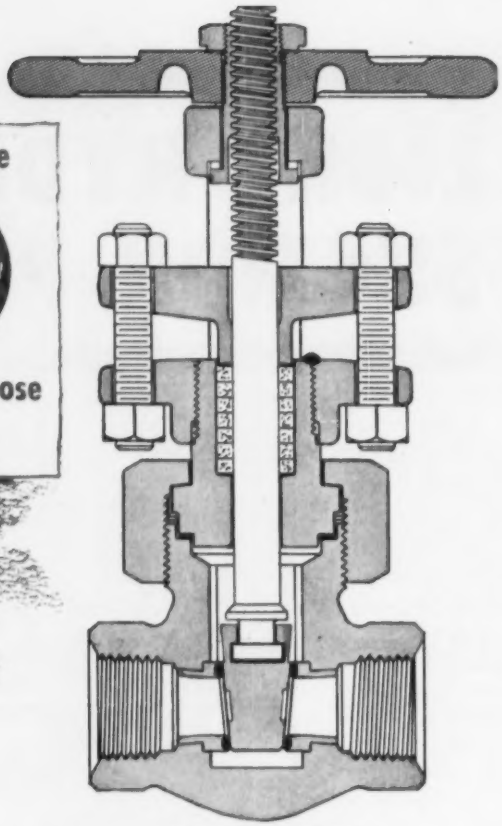


Bingham Type HSB "Double Volute" Double Suction Pump for high heads.

Bingham Type CP "Double Volute" Multi-Stage, Double-Case pump for hot or cold service.

Bingham Type VCP Vertical Pump for low NPSH conditions, featuring bottom dismantling.

For more data on advertised products, use Readers' Service Cards, last page.



G-P series 5-9530

Hard faced* Seating

. . . at no extra cost!

STELLITE *faced seating surfaces* are among the many plus advantages offered by Vogt General Purpose Valves. Fusion welded to the removable stainless steel seat rings of gate valves and to the integral seat of globe and angle valve bodies, tough, long-wearing STELLITE affords amazing resistance to erosion, corrosion and galling.

The new line of Vogt drop forged steel GP's completely fills the demands of industry for a line of compact, lighter weight, shorter face-to-face valves. They assure operation economies and longer life and are available in a complete range of sizes and types from ¼" to 2". They are rated 800 pounds at 850°F. and 2,000 pounds at 100°F. Send today for free catalog.

Adv. No. 2 in a series describing the features of Vogt G-P Valves.

Write For Your FREE COPY of Supplement No. 1 to Catalog F-9. Dept. 24-FPR

HENRY VOGT MACHINE CO.
P. O. Box 1918 • Louisville 1, Kentucky

SALES OFFICES:

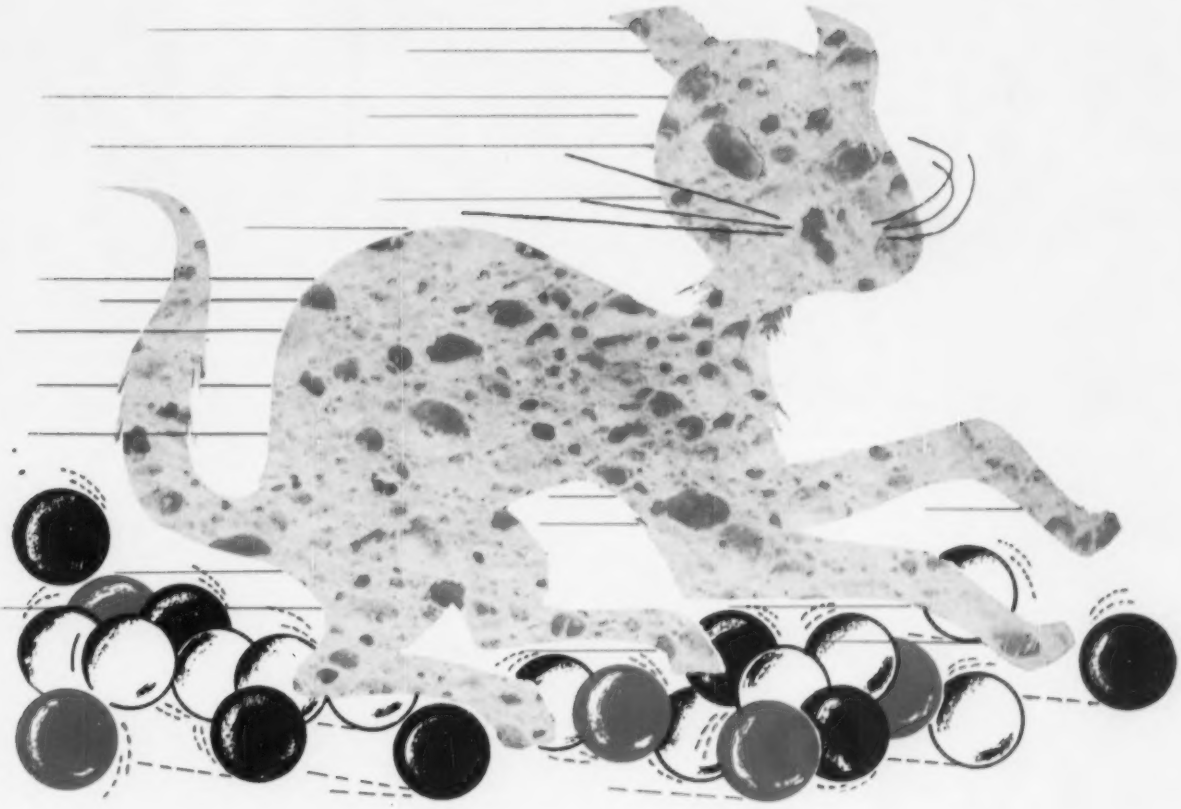
New York, Philadelphia, Cleveland, Chicago, St. Louis, Charleston, W. Va., Cincinnati, Dallas, San Francisco

Vogt GENERAL PURPOSE **GP** Vogt FOR BETTER VALVES

DROP FORGED STEEL

VALVES

For more data on advertised products, use Readers' Service Cards, last page.



SPHERICITY SPEEDS FLOW, REDUCES ATTRITION OF

balanced HI PV* Aerocat® Catalysts

Circulation improves and stack losses drop when catalyst particles are free of snags and corners that impede flow and break off to make fines.

Good sphericity is characteristic of Cyanamid's AEROCAT Catalysts. Balanced with particle size distribution and hardness, sphericity boosts efficiency of catalytic cracking. And to provide exceptional thermal and steam stability, high pore volume is carefully adjusted with pore diameter and specific surface.

Results in cat cracking unit performance are attested by extensive commercial experience, which your Cyanamid representative will be glad to review with you. Ask him today about AEROCAT, and the importance of a *balanced* HI PV catalyst.

CYANAMID

AMERICAN CYANAMID COMPANY
REFINERY CHEMICALS DEPARTMENT
30 Rockefeller Plaza, New York 20, N.Y.

In Canada: North American Cyanamid Limited, Toronto and Montreal

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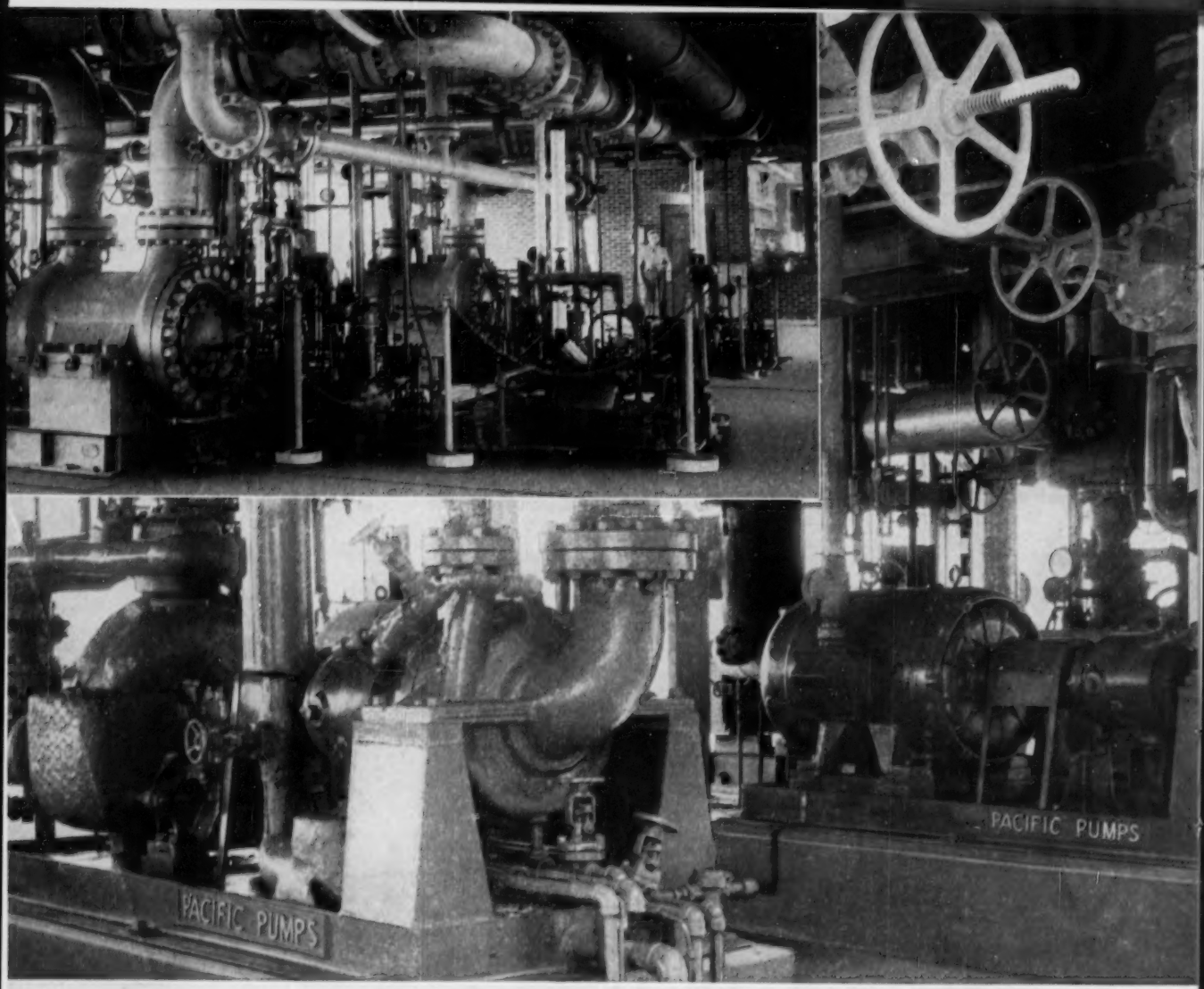


IDECO

IDECO, Dallas, Tex.—Hydrair and Power Rigs; Full-View Masts; Substructures; Single, Dual and Drive-In Rambler Rigs; Blocks, Swivels, Rotaries; Mud Pumps; Petroleum Equipment and Supplies.

Magcobar.

MAGNET COVE BARIUM CORP., Houston, Tex.—Magcobar and Magcogel drilling muds and other specialized oil well drilling fluids and chemicals.

Security

SECURITY ENGINEERING DIVISION, Dallas, Tex., Whittier, Calif. — Rock bits, reamer rock bits and hole openers; reamers, casing scrapers and Neo-Red rubber stabilizers.

CLARK

CLARK BROS. CO., Olean, New York—Gas turbines, engines, and reciprocating, centrifugal and axial flow compressors — gas, steam, electric and diesel driven.

ONE OF THE DRESSER INDUSTRIES

PACIFIC

the pump with the extra "oomph"

For more than thirty years, Pacific has supplied the refining, processing, and other industries with a range of pumps for every purpose. In the petroleum industry, Pacific pumps handle everything from the production of crudes to the finished, marketable product. For every industry, Pacific offers a rugged, durable pump for practically every purpose ... single-stage, multi-stage, horizontal and vertical types, with axial and radial split cases ... for all pressures and for extreme sub-zero temperatures and up to 850°F. Whatever your pumping requirements, you can rely on a Pacific pump to handle the work efficiently and economically.

How the DRESSER *plus* + works...

Throughout the petroleum and petrochemical industries, products of Dresser companies are teamed together to help produce and process the fuels and chemicals so vital to the modern world.

For instance, at Shell Oil Company's Deer Park, Texas refinery, Pacific process pumps team up with Clark heavy duty, barrel type multi-stage centrifugal compressors handling recycle hydrogen on reforming service. These Pacific SVC pumps shown in the large illustration have capacities to move many thousands of gallons of liquid per day. The Clark compressors illustrated at upper left are the first of these Clark barrel type units placed in operation.

In this Pacific-Clark equipment team the operators obtain the important Dresser *Plus* +... the dependability of equipment insured by the combined experience, research, engineering facilities and resources of the Dresser companies. This is realized in greater strength, better service, powerful stamina, and longer life.

You can get the Dresser *Plus* + by specifying Dresser products and equipment ... the standard of comparison the world over.

ROOTS-CONNERSVILLE BLOWER DIVISION, Connersville, Ind.—Rotary positive blowers, gas pumps, centrifugal blowers, exhausters, and positive displacement meters.

LANE-WELLS CO., Los Angeles, Calif., Houston, Tex., Oklahoma City, Okla.—Electric and Radioactivity Well Logging, Koneshot perforating and bullet perforating, packers and bridging plugs.

DRESSER-IDECO DIVISION, Columbus, Ohio—Radio and television broadcasting towers, steel buildings, aircraft hangars, mechanical parking garages, electric power substations.

DRESSER MANUFACTURING DIVISION, Bradford, Pa.—Pipe line couplings, pipe repair sleeves and clamps, weldments, forgings, welding fittings, flanges, rings.

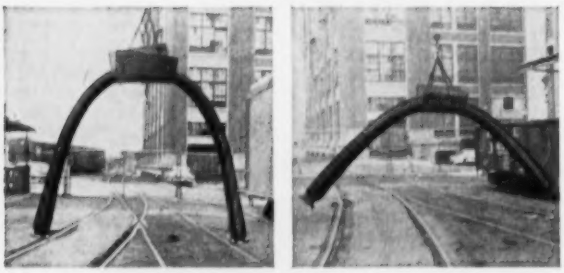
DRESSER INDUSTRIES, INC.

OIL, GAS, CHEMICAL AND ELECTRONIC EQUIPMENT AND SERVICES

REPUBLIC NATIONAL BANK BUILDING • POST OFFICE BOX 718 • DALLAS 21, TEXAS

U. S. Rubber announces another major advancement in OIL DOCK HOSE!

NEW U. S. AMAZON H-1818 Lighter Weight Suction & Discharge Hose Speeds Header Make-up, Cuts Dock-Side Time!



TWICE AS FLEXIBLE... visible proof that the new H-1818 (left) —with the same 200 lb. operating pressure rating as conventional hose (right)—is *twice as flexible!* In addition, H-1818 *weighs one-third less* per foot, has *50% lighter ends,* and provides the *greatest hydrostatic values* ever!

GET HOSE SUCTION LINES flowing quicker with this far more flexible, lighter-to-handle hose. The 8" i.d., for instance, has a bending radius of 3 feet, weighs but 18½ lbs. per foot (instead of 30 lbs.) and comes with metal connections weighing only 85½ lbs. (rather than 175 lbs.!)

The new U. S. AMAZON H-1818 Lighter Weight Suction & Discharge Hose provides—

- **Easy Handling—lighter weight and ready flexibility.**
- **Ultimate Hydrostatic Values—up to 75% higher than conventional dock hose.**
- **Greatest Safety—harmless seepage, rather than sudden burst, when hose has served its time.**
- **Positive Static Connection Through Body Wires—eliminates possibility of static bond failure.**
- **Highest Crush Resistance—with greatest flexibility.**
- **Smooth or Corrugated Covers—smooth for repeated rough moving; corrugated for more permanent installations.**
- **Lightweight Steel Nipples—with forged aluminum, bronze, steel, or cast iron flanges—as ordered.**

U. S. Amazon H-1818 is obtainable through any of our 27 District Sales Offices or write to us at Rockefeller Center, New York 20, New York.

US RUBBER

Mechanical Goods Division

United States Rubber

alkylation

...for "MOTOR" OCTANE

The persistent trend to higher compression ratios in automotive engines is focusing attention on alkylation as an important process means for increasing a refinery's Octane potential.

Foster Wheeler is currently designing and constructing an alkylation unit for a midwestern refiner which will produce 3800 bbl/day of motor alkylate. This unit features "effluent refrigeration," the most significant advance in alkylation technology in 15 years.

The unit shown in the photograph, recently completed for a South American refiner, is but one of the 17 alkylation units designed and constructed by Foster Wheeler. This cumulative experience is available to refiners everywhere — for evaluating the economics of the process and undertaking full responsibility for plant design and construction. For complete information, write to *Foster Wheeler Corporation, 165 Broadway, New York 6, N.Y.*

FOSTER WHEELER

NEW YORK • LONDON • PARIS • ST. CATHARINES, ONT.

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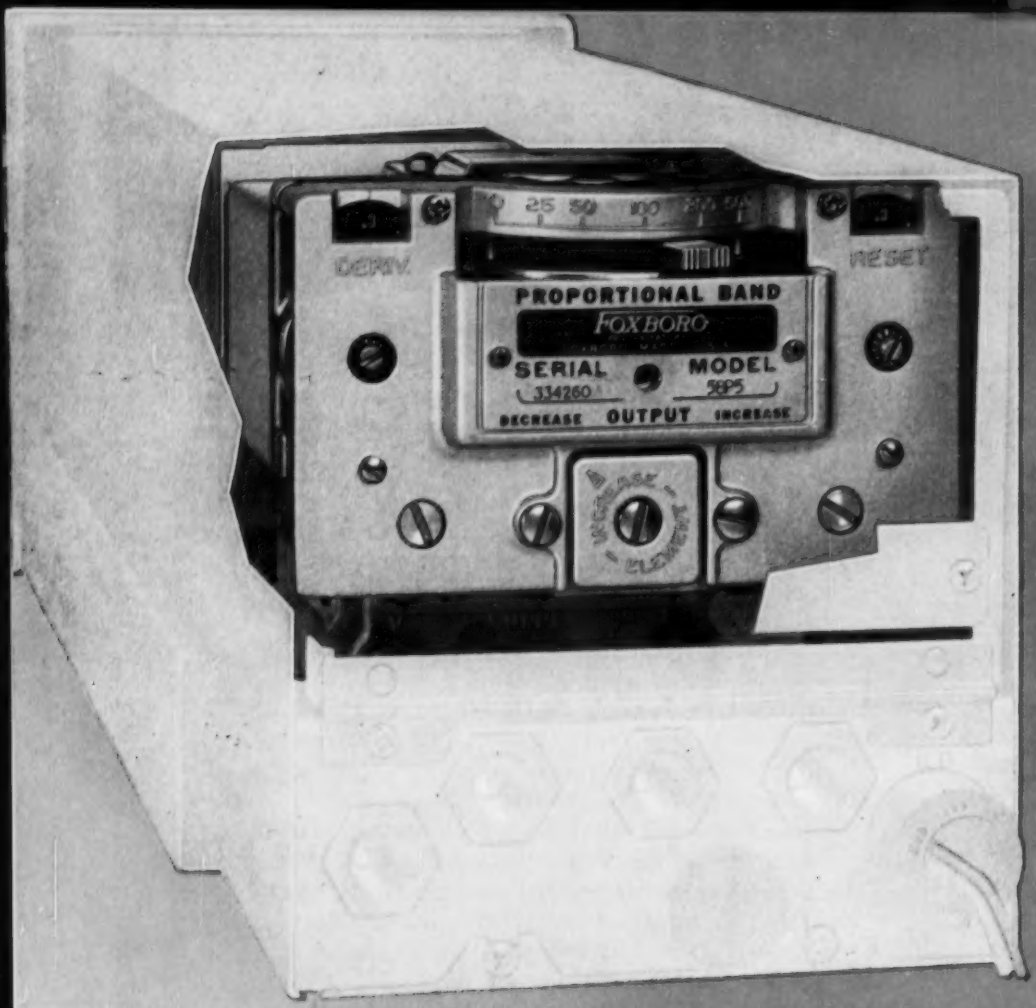


The Foxboro M/58 Consotrol Controller shown integrally mounted with Foxboro Consotrol Recorder.

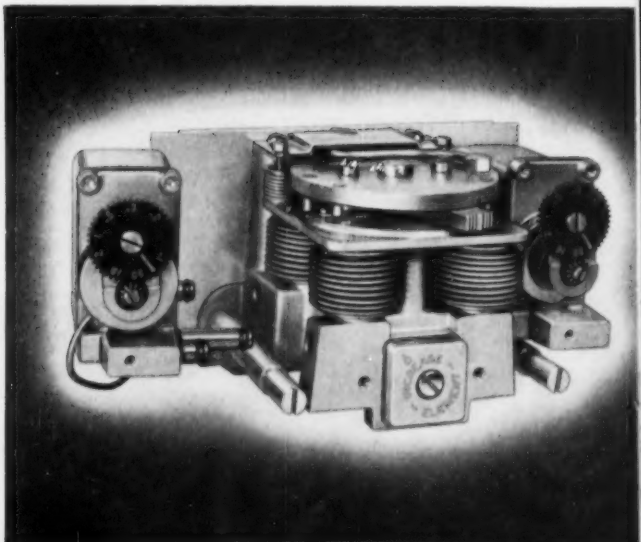
THE FOXBORO M/58 CONSOTROL

The M/58 Controller's Revolutionary Floating Disc System

Here's the exclusive Foxboro design development that gives M/58 Control its unique versatility, precision, and stability. The floating disc and matched bellows assure uniformly high controller sensitivity and pin-point control action, even at widest settings of the proportional band. Lever-set proportional band adjustment is calibrated to 500%.

Component Construction Gives Unrivaled Versatility

Not only is the complete controller easily detachable as a unit, but also, each component is a "plug-in" unit. For example, reset plugs in at right as shown; derivative, similarly, at left. All 4 control actions, with 2 reset ranges, are available and easily adjustable to widest variations in operating conditions. Proportional action from 1 to 500% quickly set by lever.



Outperforms all other controllers!

...the controller with the FLOATING DISC

If you think this claim is exaggerated, just put a Foxboro M/58 Consotrol* Controller on your process. The tougher the job, the more it will outperform other controllers! Or ask any present user . . . many of the largest, most progressive petroleum and chemical processors are using hundreds of these instruments. They will unhesitatingly confirm that this exclusive Foxoboro development has put their processes "on stream", automatically and smoothly from the control room, without false starts or confusion.

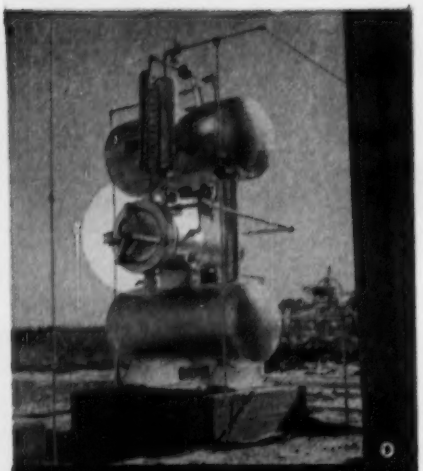
The M/58 Controller can do the same for your process. The flexibility of its control functions makes it readily adaptable to *all* processing techniques. All four actions are available, with two ranges of reset . . . all are easily adjustable to the most widely varying operating conditions. For example, reset and derivative functions plug in . . . proportional action from 1 to 500% can be quickly set by a lever. And calibration is a simple zero adjustment!

Get full details on this simple, truly "universal" Controller. Write for Bulletin 13-19 and ask your Foxboro Sales Engineer for a demonstration. **The Foxboro Company, 743 Neponset Ave., Foxboro, Mass., U.S.A.**

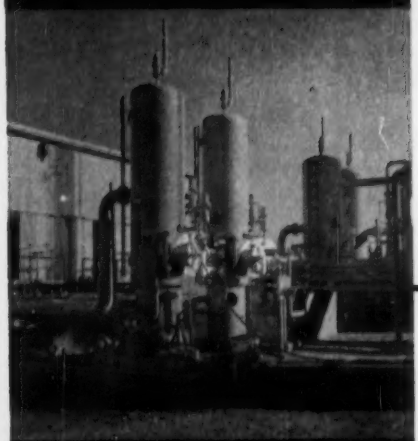
*Reg. U.S. Pat. Off.

FOXBORO **CONSOTROL INSTRUMENTS**

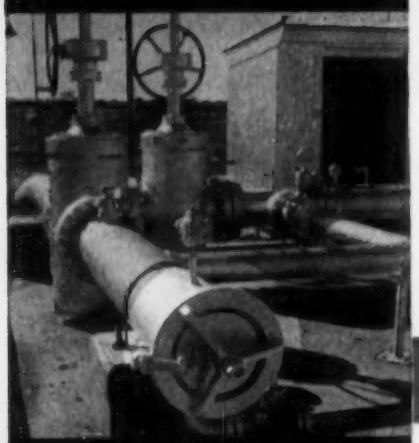
Reg. U.S. Pat. Off.



It's no effort at all to reach the internals of this Peerless Gas Odorizer through the Sillers Flex-Ring Closure.



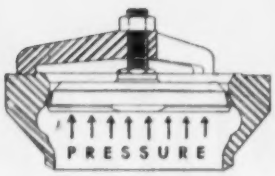
Sillers Flex Ring Closures are utilized on these large scrubbers at a Field Processing Plant in South Texas.

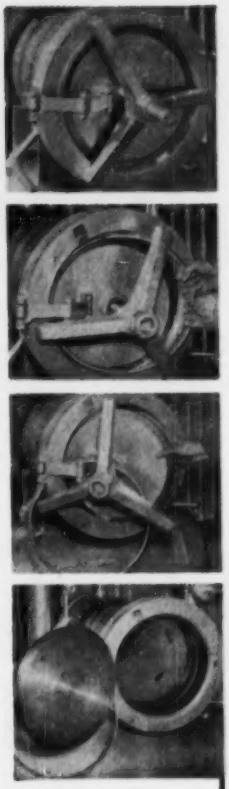


Here is a typical Sillers Flex Ring Closure installation on a Sillers Scraper trap on a products pipeline in Eastern Oklahoma.

SILLERS FLEX RING CLOSURE

for faster access to the inside of pressure vessels or piping . . .





(1). Flex Ring Unit assembled as in service. (2). Spider released, gasket being removed. (3). After gasket is removed, plug is rotated to open. (4). Unit completely opened and in a fraction of time taken for conventional type closures.

SIMPLE and SAFE to OPERATE...

An entirely new design and seal principle, the SILLERS FLEX RING CLOSURE gives you many advantages and economies such as LOW INITIAL COST . . . LESS TIME IN OPENING AND CLOSING (JUST ONE BOLT) . . . TIGHTER SEAL AT HIGH PRESSURES . . . LESS WEIGHT . . . EASE OF HANDLING . . . and NO SEAL DESTRUCTION IN CASE OF FIRE. Sillers Flex Ring Closures are available in all standard sizes and can quickly be adapted for special applications.

GET COMPLETE DETAILS TODAY
SEND FOR BULLETIN NO. 3000

The perfect closure for Boilers, Evaportors, Heat Exchangers, Autoclaves, Filters, Strainers, Absorbers and all types of Pressure Vessels and Piping Systems.

FOR USE ON

BOILERS
EVAPORATORS
HEAT EXCHANGERS
FILTERS
STRAINERS
ABSORBERS
PRESSURE VESSELS

SILLERS ENGINEERING COMPANY

Division of Peerless Manufacturing Company

BOX 13165 DALLAS, TEXAS

Representatives in Principal Cities

For Optimum Efficiency at Minimum Cost, Heat Transfer Equipment Needs Kellogg's

BUILT-IN ENGINEER

WHEN a process plant's efficiency, and even its economic success, depends on the performance of heat exchangers, this vital equipment becomes more than a "packaged" item or even a matter of following specifications. Optimum performance, at minimum cost to the customer, demands all of the extra know-how, know-when, and know-where that the fabricator can put into the job. It requires, for example, a thorough knowledge of heat transfer, stress analysis, metal fatigue, corrosion control, metallurgy, and welding techniques, plus the inherent ability to apply this knowledge to the specific problem at hand.

At M. W. Kellogg, the instinctive application of this kind of knowledge—which goes into the design and fabrication of every Kellogg heat exchanger or other processing unit, is what we call the "built-in engineer". This important extra, together with Kellogg's other facilities guarantees performance, minimizes maintenance, and often reduces initial costs. In one recent instance, a saving of $5,000 for a customer resulted from a slight change in design suggested by Kellogg's staff.

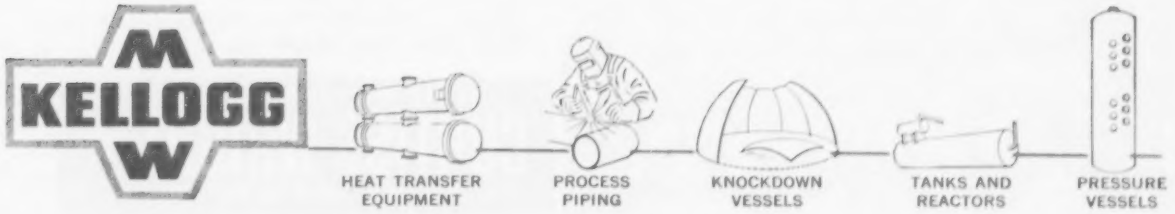
We welcome the opportunity to demonstrate, in cooperation with your own design engineers or alone, what Kellogg's "built-in engineer" can contribute to *your* new process equipment.

Fabricated Products Division

THE M. W. KELLOGG COMPANY, 225 BROADWAY, NEW YORK 7, N. Y.

The Canadian Kellogg Company, Limited, Toronto • Kellogg International Corporation, London

SUBSIDIARIES OF PULLMAN INCORPORATED



For more data on advertised products, use Readers' Service Cards, last page.

CURTISS-WRIGHT METALS PROCESSING DIVISION CAN COMBINE QUALITY WITH ECONOMY IN YOUR PRODUCTION TOO!

This nickel alloy casting by the Curtiss-Wright Metals Processing Division costs 40% less than identical previous castings. The saving, however, is almost a sidelight to the fact that specialized know-how can discover routes to quality that are often far shorter as well as less expensive.

High Standards, Lower Cost

In this case the answer to meeting high standards and lower cost was ceramic mold instead of investment casting. This method in experienced hands retained the close tolerances required . . . produced castings faster, and with gratifying economy.

Metals Processing Division metallurgical specialists can find answers for you, whether in ceramic, shell, centrifugal or other techniques . . . standard or special. You will profit by long-proven engineering ability and unmatched facilities in production and testing. When requirements are critical, when precision must be combined with resistance to heat, stress, wear and corrosion, it's time to call on Curtiss-Wright—a primary source for castings, forgings and extrusions.

METALS PROCESSING DIVISION
CURTISS-WRIGHT
CORPORATION · BUFFALO, NEW YORK

70 Grider Street, Buffalo, New York

For more data on advertised products, use Readers' Service Cards, last page.

Now–the Plant You Dream about...

Maintenance-Free because of Aluminum

Here's Why:

Aluminum resists rust and corrosion due to chemicals, gases, plant atmospheres, and coastal environments. You save the expense of painting and enjoy the natural bright appearance of this long-lasting metal. You save on replacement of parts destroyed by corrosion.

Build with Aluminum Throughout

Aluminum Structurals give you strengths equal to structural steel with only ⅓ the weight. Ideal for framework and supports.

Aluminum Jacketing provides maintenance-free beauty plus the benefits obtained from natural insulation.

Aluminum Tread Plate is strong and lightweight, will not spark, resists rust and corrosion.

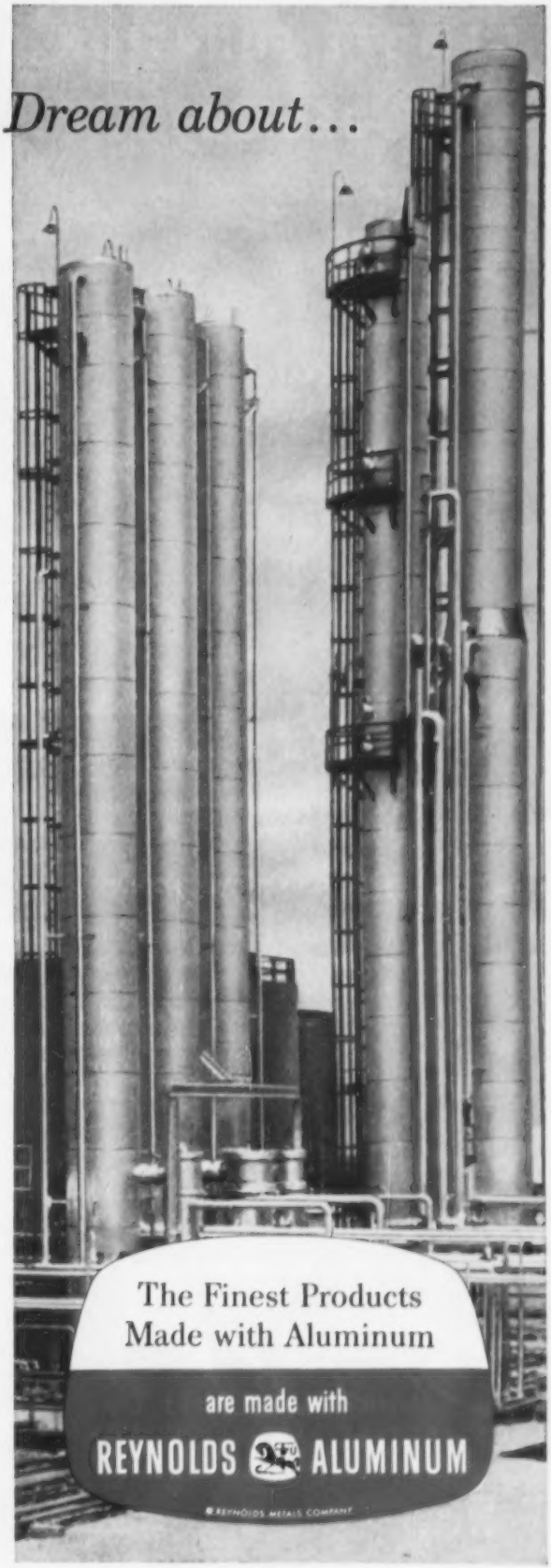
Aluminum Heat Exchanger Tubing offers lower initial cost, provides lower service costs.

Aluminum Accessories for gratings, railings, ladders and walkways.

Aluminum Process Pipe will not contaminate refined liquids and gases.

Get Complete Details Today

Call the Reynolds office listed under "Aluminum" in your classified telephone directory. Or write to *Reynolds Metals Company, P. O. Box 1800-CT, Louisville 1, Kentucky.*



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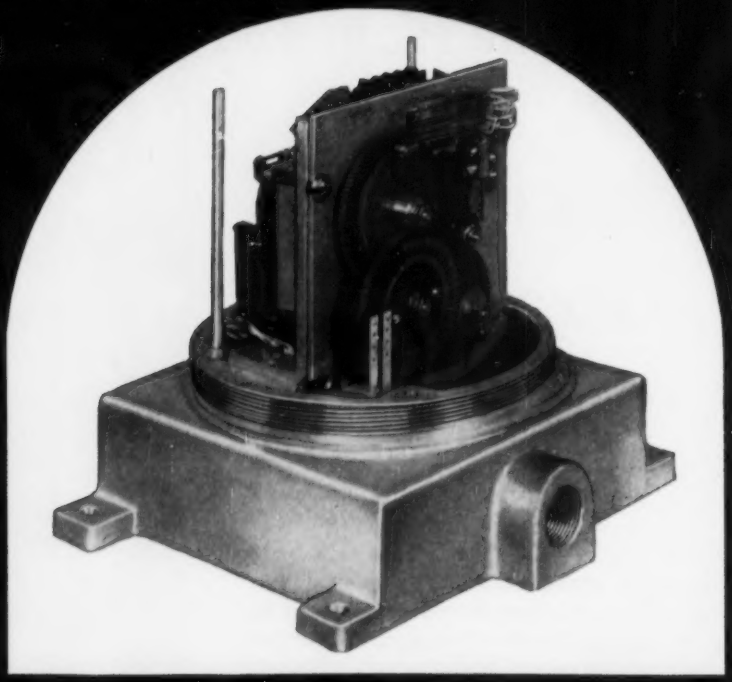
REMOTE FUNCTION CONTROL

ADDED TO

S&J

Telepulse



WHAT IS IT?

An electronic device for controlling remote functions such as motorized valves, starting or stopping of motors, pumps, compressors, etc. Can be used between any points where communications facilities reach, whether by private or leased wires, carrier or Microwave. As easily installed as another Telepulse Gaging Transmitter.

HOW DOES IT WORK?

The operator selects the position which controls a remote function, presses the button, the station selected responds with a signal confirming proper selection, then indicates its present condition. If the operator wishes to change that condition from open to closed, or from closed to open, pressing a button does the job, no matter how far distant the remote function is from the operator. After this change, the Remote Function Control automatically sends back to the operator a confirming signal indicating that the indicated change has taken place.

CAN YOU USE IT?

Very easily if you now have an S. & J. Telepulse System of Automatic Remote Tank Gaging. The Remote Function Control will enlarge its field of service. You may anticipate a further expansion of the field of usefulness of the S. & J. TELEPULSE.

Shand and Jurs Co.

BERKELEY 10, CALIFORNIA

NEW YORK
342 Madison Ave.

HOUSTON
M & M Bldg.

TULSA
Thompson Bldg.

CHICAGO
10409 S. Western Ave.

LOS ANGELES
6399 Wilshire Blvd.

REPRESENTATIVES:
SEATTLE: Nebar Supply Company, 3000 Western Avenue
MONTREAL: Lytle Engineering Specialties, Ltd., 360 Notre Dame St., W.
TORONTO: Lytle Engineering Specialties, Ltd., 69 Eglinton East
VANCOUVER: P. D. McLaren & Son, Ltd., 3277 Main Street
CALGARY: P. D. McLaren & Son, Ltd., 510 - 9th Ave. W.
MEXICO, D.F.: Dalmar Comercial, S. A.
CARACAS: Sinclair Spence, C.A., Edificio Galipan
ENGLAND: Whessoe, Ltd., Sales: 25 Victoria St., London S. W. 1
Whessoe, Ltd., Works: Darlington, County Durham

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HOLLOW FORGINGS
By the mile

For Power Plants, Chemical Plants and Refineries

During the year 1955, orders were placed with The Babcock & Wilcox Company for nearly 39,000 feet (more than 7 miles) of Hollow Forgings.

This acceptance came about for three sound reasons:

1. Quality of Product
2. Engineering Ability
3. Manufacturing Facilities

B&W Hollow Forgings are available in sizes to 35⅝ inches O.D. in a wide range of analyses. This broad choice is made even more desirable by assured prompt delivery of both large and small quantities. Your production schedules can be met with the size, quantity and analyses you specify.

For complete B&W Hollow Forgings data send for Bulletin S-16B to The Babcock & Wilcox Company, Process Equipment Department, Barberton, Ohio.

BABCOCK & WILCOX

BOILER DIVISION

S-450

ALUNDUM*

High-Purity Fused Alumina

How can you use it to advantage?

Among the many electrochemically refined materials produced by Norton Company, ALUNDUM fused alpha alumina is one of the most widely useful to industry. Thanks to its inherent properties of hardness, chemical stability and high density, engineers in various fields are finding many new applications for it.

Norton fused alumina is produced in a number of forms. Of these, 38 ALUNDUM* grain has proved particularly successful in applications demanding high purity. Electrically fused from Bayer-processed alumina, this white grain is shown by typical chemical analysis to be 99.49% pure Al_2O_3. It is insoluble in common solvents and extremely resistant to reduction. It is an amphoteric refractory and has high dielectric strength. Other characteristics include:

Melting point	**about 3600°F.**
Specific gravity	**3.94**
Crystal structure	**hexagonal system (rhombohedral division)**
Hardness	**9.0 Mohs' scale**
Index of refraction	**1.76 mean**

Typical Product Applications in which Norton high-purity fused alumina is now working out to advantage are:

For Catalytic Reactions. **Norton fused alpha alumina carriers are outstanding for chemical stability and resistance to abrasion and erosion. Available in the form of spheres, rings and pellets they are used both in fixed bed oxidation reactions and as inert, low-density carriers for space filler applications where a low surface area (less than 1m²/gm) is required. Other types of ALUNDUM catalyst carriers having surface areas in the range 5-60 m²/gm are also available.**

In Pebble Heaters. **ALUNDUM heat exchange pebbles are giving excellent results in pebble heaters for heating gases above operating temperatures permissible in conventional tube furnaces. Their great resistance to abrasion, impact and repeated heating and cooling make them the ideal heat transfer medium in these devices. Also, their high refractoriness prevents them from the softening and "bridging" together that causes stoppages in the heater's moving bed.**

In Thermal Cracking Reactors. **Particularly in Wulff Process Generators for cracking light hydrocarbons to produce acetylene gas and Koppers-Hasche Generators for cracking light hydrocarbons to produce a variety of gases and petrochemicals — checkers made of Norton ALUNDUM high-purity fused alumina provide definite advantages. Their excellent heat transfer properties, high refractoriness and resistance to erosion caused by hot gases are important Their ability to withstand the thermal stresses of intermittent operation assures long life. And their purity prevents side reactions with the reacting gases, thus safeguarding product quality.**

In Gas Synthesis Generators. **ALUNDUM fired shapes are ideal for lining generators of this type. Among the inherent characteristics of Norton high-purity fused alumina that work out very well are: high refractoriness, chemical stability, and inertness that prevents reacting with the contacting atmospheres.**

Very many other uses for Norton high-purity fused alumina materials include: pure oxides and sintered refractories, refractory cements, wear-resistant parts, laboratory ware, coatings for rocket and jet plane parts and atomic energy equipment.

Other Norton Electrochemically Refined Materials

include CRYSTOLON* silicon carbide, MAGNORITE* magnesium oxide, NORBIDE* boron carbide, FUSED ZIRCONIA and many others, including a number still under development. These high-melting materials, which have varied applications in many fields, are also the basic ingredients of the famous Norton Refractory Rx's — refractories *engineered and prescribed* for the widest range of uses.

For Your Own Applications Or Developments

Norton Company not only supplies these materials in crude form, but has extensive facilities for processing and fabricating — and is ready to work with you in engineering materials to your particular requirements. A new booklet "Norton Refractory Grain — Electrochemically Refined" contains detailed information. For your copy, write to NORTON COMPANY, Refractories Division, 462 New Bond Street, Worcester 6, Massachusetts.

NORTON

REFRACTORIES

Engineered... Rx... Prescribed

Making better products... to make your products better

*Trade-Marks Reg. U. S. Pat. Off. and Foreign Countries

TURBINES FOR
HIGH-SPEED COMPRESSORS

Six General Electric high-speed turbines operate on 'round-the-clock compressor service at Gulf refinery in Port Arthur, Texas.

For greater bucket reliability, G-E engineer locates "quiet zone" of resonant vibration in buckets to assure that steam-impact frequencies and natural bucket frequencies do not coincide.

MORE THAN JUST RATING AND SPEED . . .

You buy reliability when you specify a G-E High-speed Turbine

IN PROCESS INDUSTRIES, where outages can cost upwards of $20,000 a day, turbine reliability is a major consideration when specifying compressor and blower drives. General Electric mechanical-drive turbines have built-in reliability features that can assure minimum down-time and greater profits for your operation:

HEAVY-DUTY ROTORS are machined from a single forging to withstand years of continuous high-speed operation. The rotor is completely balanced without buckets, then balanced again as each wheel is bucketed.

EXTERNAL DOVETAIL BUCKETS are attached to wheel rims with machine fit. External construction assures proper force distribution at high speed, gives better rotor protection from moisture erosion.

LARGE PRESSURE PAD BEARINGS furnished on all G-E high-speed turbines minimize shaft vibration. Generous bearing surfaces assure low unit loading for ample lubrication and minimum wear during turbine start-up.

FLANGED CONNECTIONS provide safer oil piping joints, eliminate potential fire hazards. Oil piping gages and pressure switches arranged to reduce possibility of oil spray on hot turbine parts.

CARBON PACKING used in addition to metallic labyrinth packing assures efficient steam sealing on G-E high-speed turbines. Carbon rings in external packing boxes are non-sizing, have high mechanical strength in the small sizes used.

POSITION RESTORED GOVERNING SYSTEM is designed for close accurate governing in response to load requirement and the slightest variations in steam conditions. Governor will operate with any recycle controlling system.

These are but a few of the important design features that account for consistent reliability of General Electric high-speed mechanical-drive turbines. For further information, contact your nearest G-E Apparatus Sales Office, or write for new bulletin GEA-6232, General Electric Company, Section 241-5, Fitchburg, Mass.

Progress Is Our Most Important Product

GENERAL ELECTRIC

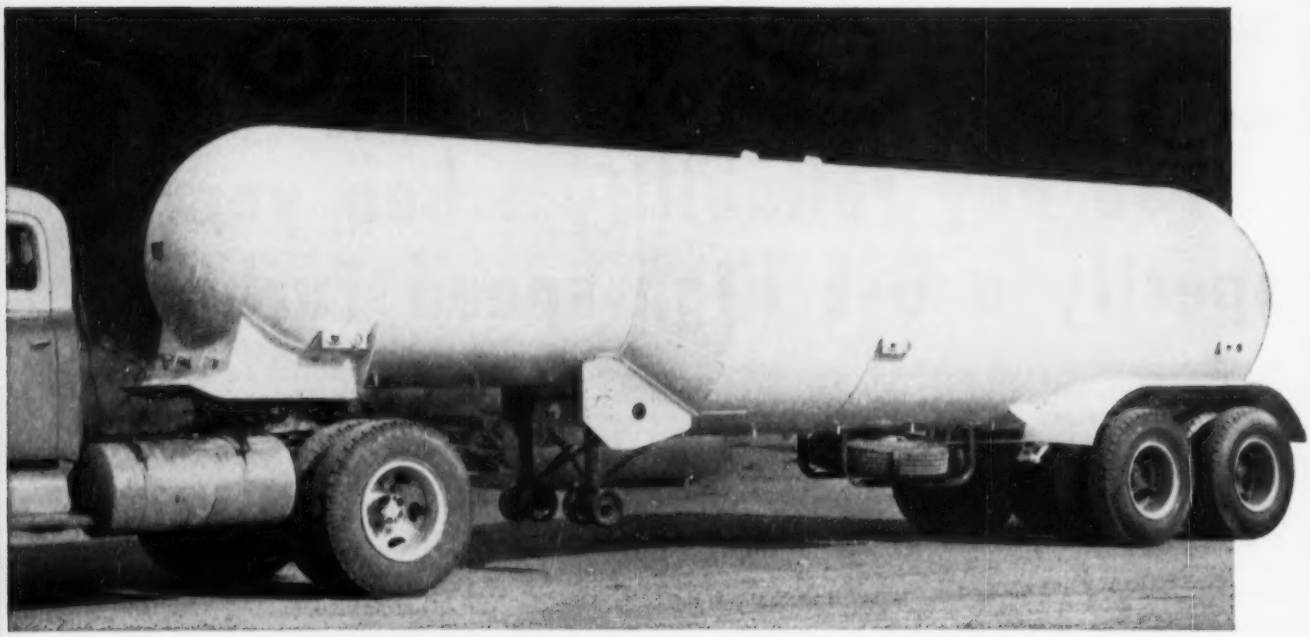
For more data on advertised products, use Readers' Service Cards, last page.

USS "T-1" STEEL BOOSTS PAYLOAD

In mobile tank trucks like this one, new USS "T-1" Steel is expected to reduce deadweight by more than a ton. That means an *extra ton of LP gas* can be carried on each trip. It means faster delivery, lower transporting cost, greater profit.

It was for jobs like this that United States Steel developed USS "T-1" Steel. Jobs that need tremendous strength to withstand high tensile stresses . . . tremendous toughness to withstand jars and jolts, and to perform in any weather with no chance of brittle failure. Jobs that demand good weldability to cut the cost and difficulty of fabrication.

USS "T-1" Steel gives you a yield strength of 90,000 psi minimum, and a tensile strength of 105,000 psi minimum. It is so tough that it will successfully withstand severe impact at sub-zero temperatures, and with the proper electrodes, "T-1" is as easy to weld as carbon steel.



FREE LITERATURE Case 1204, a special ruling of the ASME Boiler and Pressure Vessel Committee, gives full particulars about the use of "T-1" in vessels, which can be applied to mobile tank units. Write for your free copy. We'll also send you full technical information on the use of "T-1" in other applications where it enables you to reduce weight or cost, or to increase strength or durability in rugged service. Write or wire, United States Steel, Room 5225, Pittsburgh 30, Pa.

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UNITED STATES STEEL EXPORT COMPANY, NEW YORK

USS "T-1" CONSTRUCTIONAL ALLOY STEEL

USS

UNITED STATES STEEL

Throughout petroleum refining...

FLUOR BUILDS PROCESSES INTO PROFITS

Since it went on-stream in July, 1955, Salt Lake Refining Company's catalytic cracker at its Salt Lake City refinery has proved over and over that you can be *sure* with Fluor. A key intermediate unit, it efficiently converts heavy oils to gasoline fractions in their high-octane gasoline production.

Completed *on schedule* despite highly unseasonal weather, this efficient, modern processing unit is typical of Fluor's 65 years of *demonstrated dependability.* It shows why, in the petroleum, chemical, petrochemical and chemical-fertilizer industries and in the generation of electric power, more and more firms are turning to Fluor for both engineering and construction.

ON SCHEDULE COMPLETION *of Salt Lake Refining's Catalytic Cracker was accomplished by Fluor in spite of heavy, out-of-season snows.*

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Engineers • Constructors

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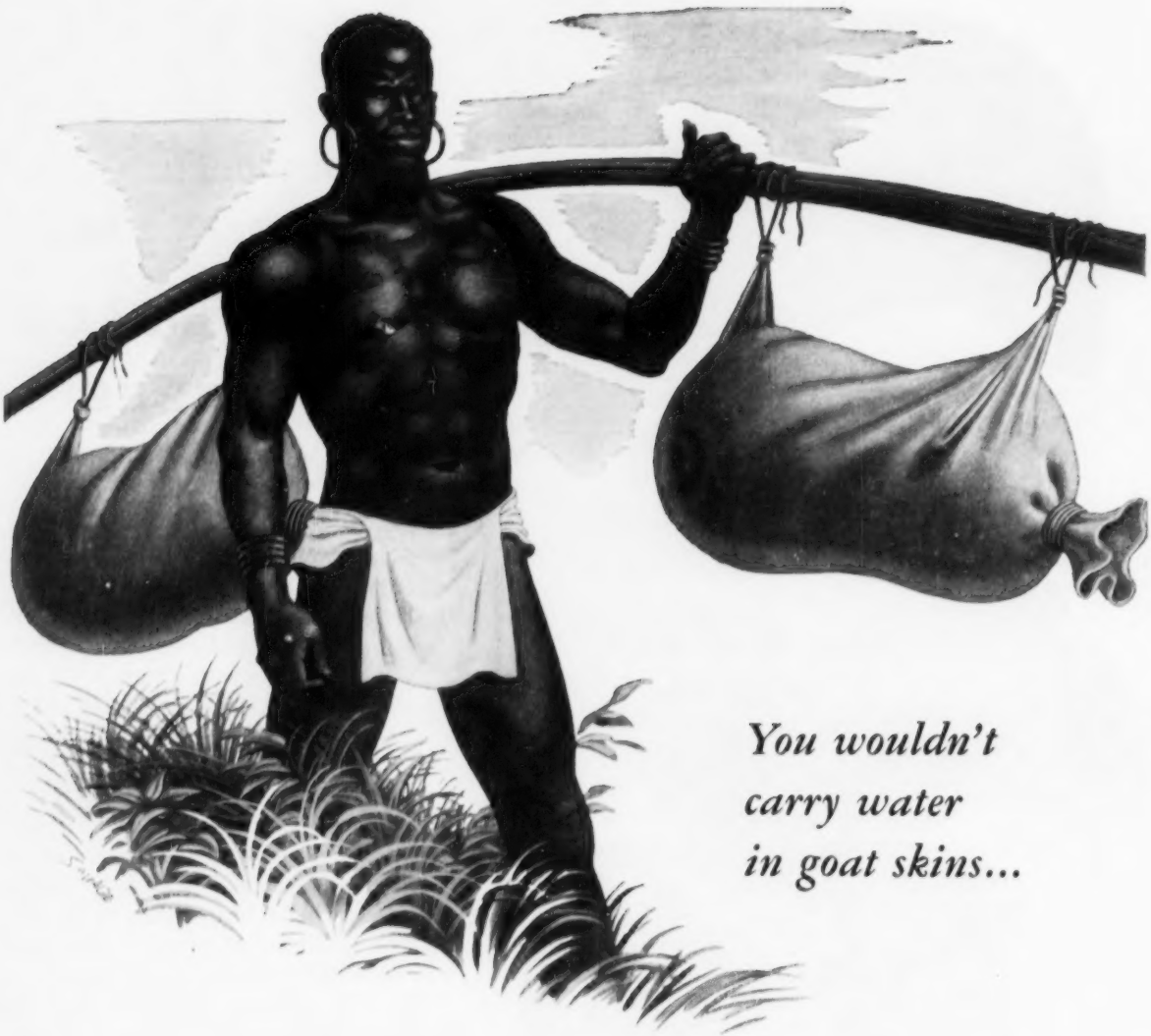

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...so why ship liquids the old fashioned way?

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Shippers' Car Line is the exclusive sales agent and lessor of the ACF-built DURADOME tank car. When you buy or lease from Shippers' you get the finest tank cars available today. What's more . . . SHPX tank cars comprise the most modern fleet in operation . . . backed by ACF engineering and a nationwide network of car repair shops to assure modern, efficient maintenance. Contact your Shippers' representative for all the details of *modern* tank car service—developed through more than 35 years experience in the leasing, operation and maintenance of tank cars for industry.

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About The Authors

VLADIMIR A. KALICHEVSKY is widely known in the refining industry. Author of many articles on petroleum and a contributor to the REFINER since 1944, his published works include several books on refining. Kalichevsky joined Union Oil Company in 1924, after completing an engineering degree at California Institute of Technology. After some years as a research chemist with that company and a similar position with Standard Oil Development Company, he became a section leader in the Research & Development department of Socony-Vacuum Oil Company, Inc., and in 1937 was named general supervisor of the department. Since 1944, he has been consulting chemical engineer for Magnolia.

KENNETH A. KOBE is a professor of chemical engineering at The University of Texas, where he is also associate director of the Bureau of Industrial Chemistry which is engaged in research on natural resources. A registered professional engineer in Texas, he has been an industrial consultant since 1931. His industrial experience includes work with Bradley-Fitch Company on recovery of low-grade ores. Kobe also worked for Du Pont Ammonia Corporation and National Safe Protector Company, and was retained for three years as technical director for Manganese Products, Inc. He is the author of over 110 published articles, several of which have appeared in PETROLEUM REFINER.

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This book is a comprehensive up-to-date treatise explaining in easy-to-read language the various problems encountered in refining and finishing petroleum products. Detailed explanations are given on refining of petroleum with chemicals and solvents, use of additives for improving quality of petroleum products, modern testing methods and their interpretations, concept of color (as applied to color of petroleum oils), as well as other theories such as lubrication, viscosity, surface tension, vapor pressure, boiling point, fire and flash point, octane number, etc. The extensive list of thousands of patents on subjects covered, and the wealth of references to the literature are of particular value.

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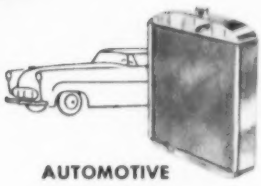
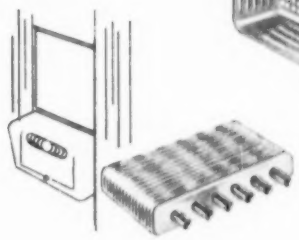
Strip

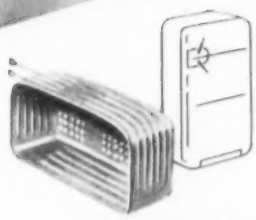
not a "sandwich", not welded, brazed or bonded



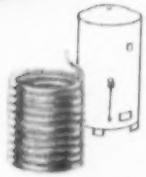
AUTOMOTIVE



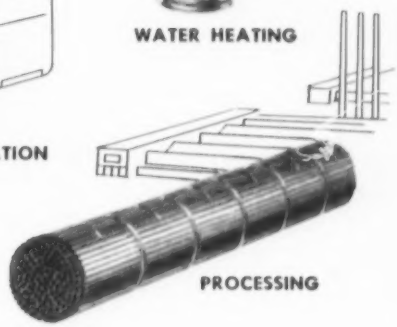
AIR CONDITIONING



REFRIGERATION



WATER HEATING



PROCESSING

Here, for the first time, is a combination of tube and strip that is made from a single piece of metal! No joints! The product of intensive development by Revere's Research and Development Department, which sought and found a brand new way to give American industry tube plus strip that is more economical to buy, more economical to work, stronger and more efficient in performing 1,001 tasks.

Remember Revere Tube-In-Strip is solid, not two strips welded, brazed, or bonded together.

What does this mean to you? You buy strip, fabricate it as you wish, stamping, bending or forming it, and then as a final operation inflation expands the integral channels into tubes. Expanding in the open, the tubes are round; by expanding into dies, the tubes can be made rectangular, fluted, half-round, hexagonal, etc.

METALS: Copper, Brass, other Copper Alloys, Aluminum, many others.

ECONOMY: You save in first cost, and in fabrication. New and improved designs are made possible. The web between the tubes conducts heat faster. The vastly increased structural strength means you can use lighter gauges, saving in weight and in price.

The applications of this radically new, different and superior Revere Product are unlimited. We most proudly present Revere Tube-In-Strip to the designers and manufacturers of American Industry. The Revere Technical Advisory Service and the Research and Development Department will gladly collaborate with you in taking full advantage of this marvelous new material.

SOME OBVIOUS USES

REFRIGERATION
- Condensers
- Evaporators
- Cooling Coils
- Cold Walls

AIR CONDITIONING
- Condensers
- Evaporators

HEAT EXCHANGERS
- Process Industries
- Chemical Industries
- Petroleum Industry

INSTRUMENT LINES

WATER HEATERS AND COOLERS
- Domestic
- Commercial

RADIANT PANEL HEATING

BASEBOARD RADIATORS

AUTOMOTIVE
- Car and Truck Radiators
- Heating and Cooling Panels
- Transmission Oil Coolers

AIRCRAFT

SOLAR HEATING

ELECTRICAL INDUSTRY
- Oil Coolers
- Gas and Fluid Heat Exchangers

AUTOMATION
- Control
- Recording
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FOOD PROCESSING

BEVERAGE INDUSTRIES

ARCHITECTURE AND BUILDING
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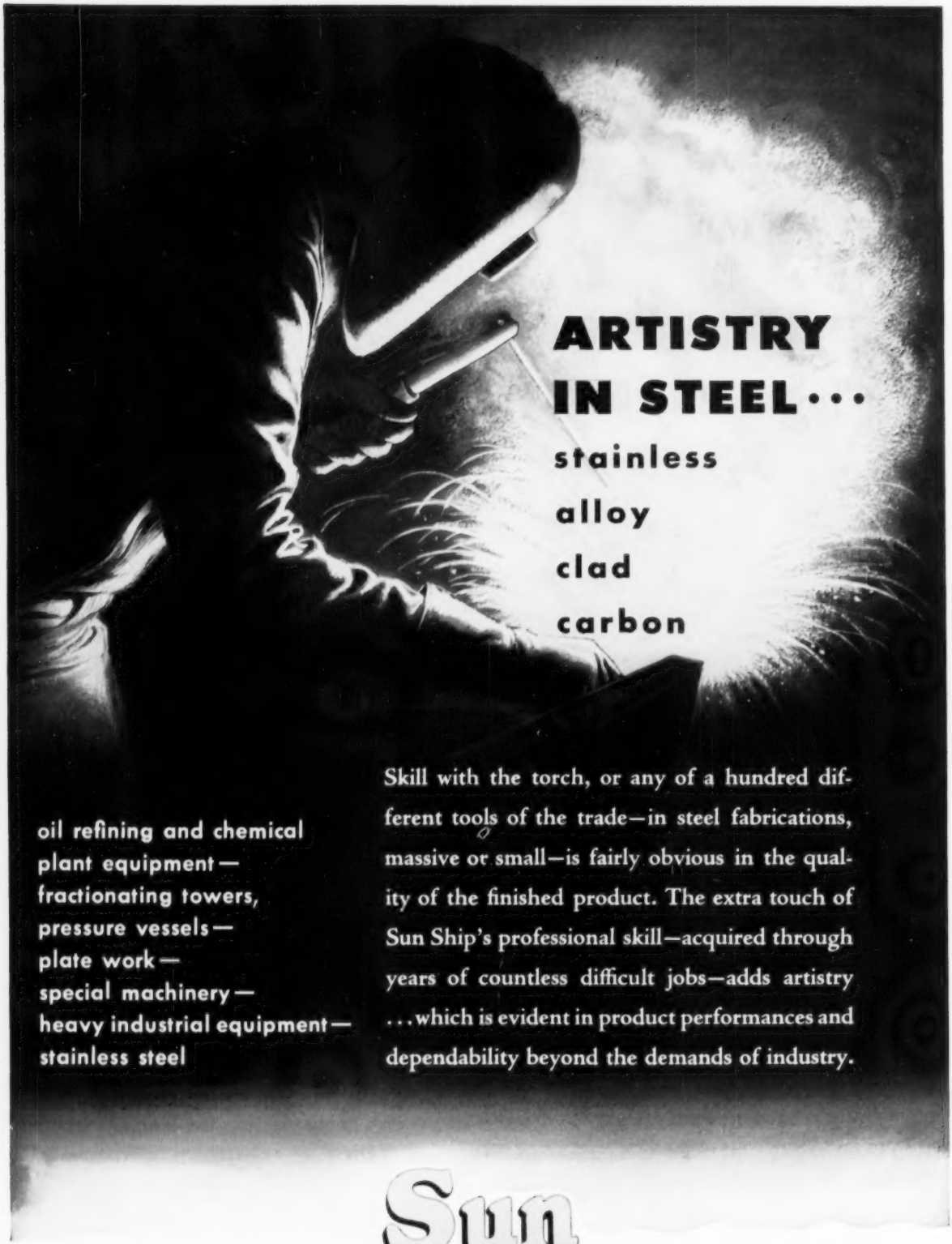

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plant equipment—
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plate work—
special machinery—
heavy industrial equipment—
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Skill with the torch, or any of a hundred different tools of the trade—in steel fabrications, massive or small—is fairly obvious in the quality of the finished product. The extra touch of Sun Ship's professional skill—acquired through years of countless difficult jobs—adds artistry ...which is evident in product performances and dependability beyond the demands of industry.

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New Armaflex® pipe insulation stops condensation, increases efficiency of lines at 32° to 200° F. Closed cellular structure positively seals out water and vapor. Installed in one fast, easy step, Armaflex can be slipped on pipes or tubing, or slit and cemented. Flexible Armaflex follows contours of formed tubing without any cutting or fitting. It resists most solvents, oils, and corrosive chemicals and is self-extinguishing. Made 6′ long, ⅜″ and ½″ thick, for ⅝″ to 3⅛″ ID tubing and pipe.

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*TRADE-MARK

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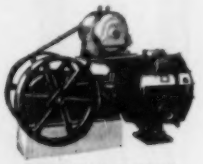
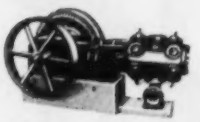
Heavy-duty
ES compressors

provide maximum efficiency in a
WIDE RANGE OF APPLICATIONS

. . . with unusual flexibility of drive and cylinder arrangements



OVERHEAD MOTOR

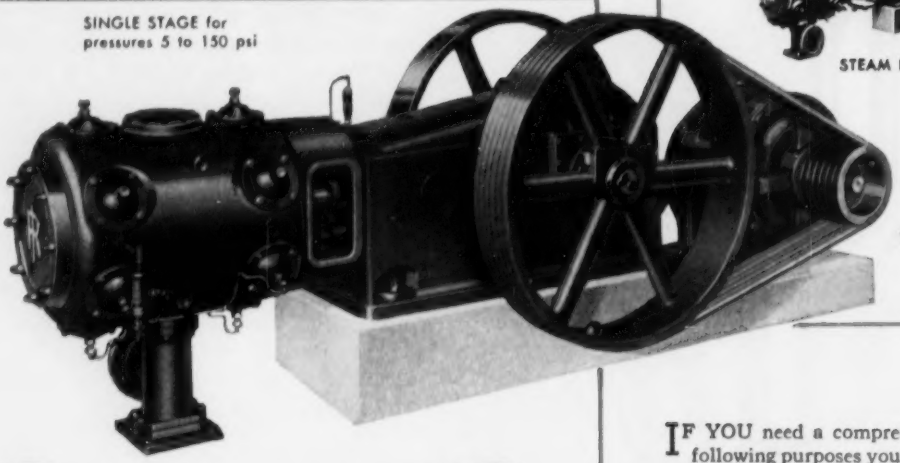


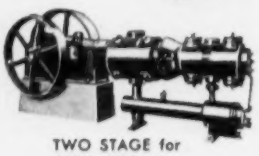
DIRECT-CONNECTED SYNCHRONOUS MOTOR

STEAM DRIVE

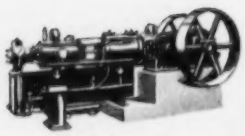
V-BELT DRIVE

SINGLE STAGE for pressures 5 to 150 psi

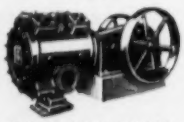




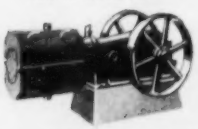
TWO STAGE for 150 to 500 psi



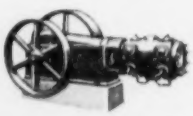
THREE STAGE for 500 to 2500 psi



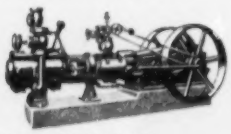
DRY VACUUM PUMPS . . . single or two stage



STEAM-PRESSURE BOOSTERS



NON-LUBRICATED CYLINDERS for oil-free air or gas



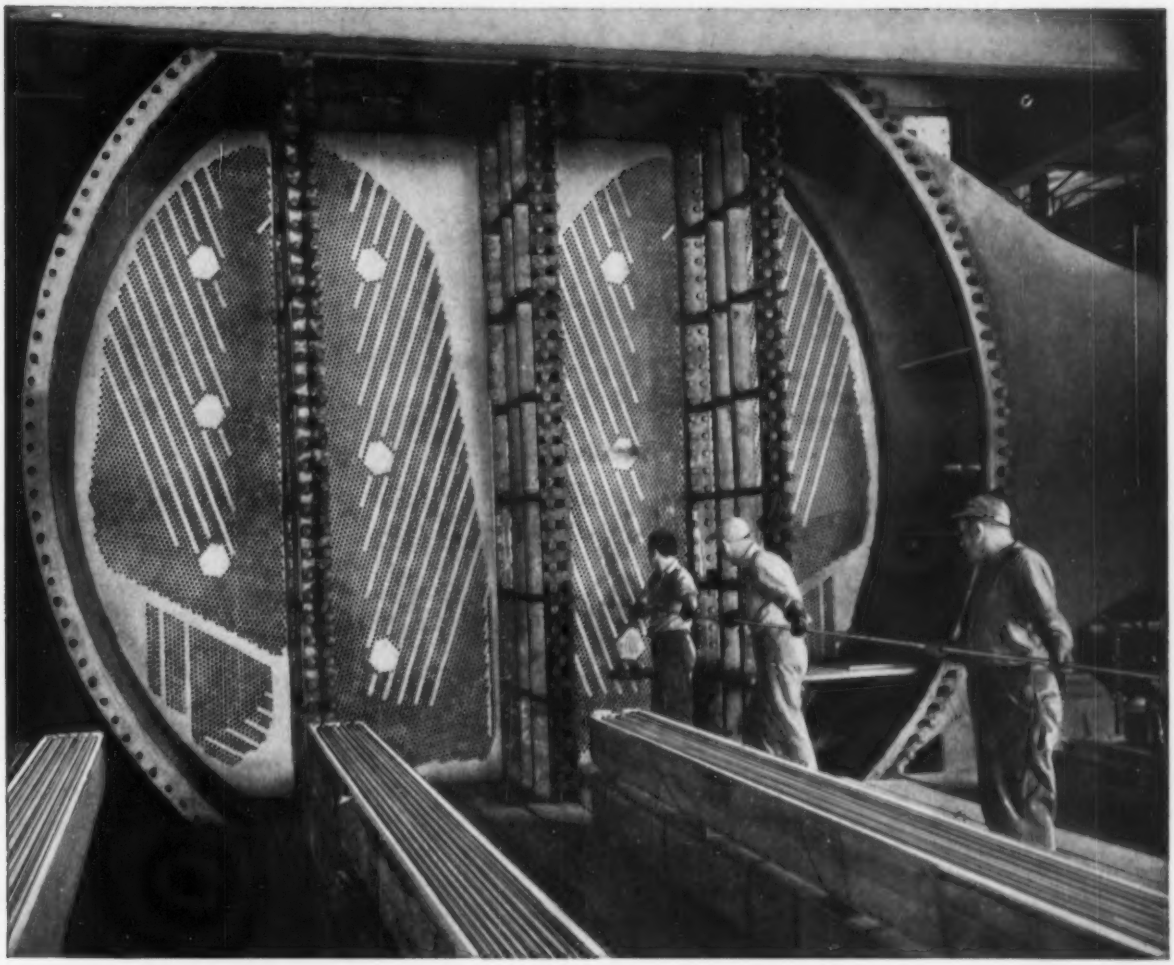
REFRIGERATION UNITS for ammonia or other refrigerants

IF YOU need a compressor for any of the following purposes you should consider the Type "ES" compressor . . . a standardized, yet extremely flexible compressor built by Ingersoll-Rand, the pioneer compressor builder.

- To compress air or gas to any pressures between 5 and 2500 psi, or for pulling vacuums. (Stock cylinders are normally available for all frame sizes, see illustrations.)
- For capacities requiring from 7½ to 150 horsepower. (Six frame sizes are available.)
- For continuous full-load operation day after day, week after week.
- For handling poisonous, inflammable, or other gases where leakage must be avoided.
- Where compressed air or gases must be free of all traces of oil. (Type NL cylinders require no oil, glycerine, grease or water for lubrication.)
- Where a future change in pressure conditions may call for a change in cylinder sizes.
- Where power cost is an important factor.
- To act as an economical standby unit for larger compressors whose full capacity is not required at all times.

Ingersoll-Rand
1-347 11 Broadway, New York 4, N. Y.

COMPRESSORS • CONDENSERS • AIR & ELECTRIC TOOLS • TURBO BLOWERS • PUMPS • ROCK DRILLS • GAS & DIESEL ENGINES



IN FOR A BIG HEAT-TRANSFER JOB

...AND MANY YEARS OF SERVICE FROM

CHASE® ANTIMONIAL ADMIRALTY TUBE!

Remove 988 Btu's per pound of steam! Condense 1,046,830 pounds of steam per hour! Cool with raw lake water! That's the job of a single-pass condenser for a Great Lakes power and light company.

Tube dezincification is as much a problem in *this* heat-exchanger unit as it is in petroleum refineries. But Chase Antimonial Admiralty was selected for the tubes in this installation with many years of trouble-free service anticipated.

You see, Chase Antimonial Admiralty condenser and heat exchanger tubes have *virtually eliminated* tube failures caused by dezincification. Perfect alloying and tempering provide freedom from season cracking and permit easy rolling into tube sheets. And rigid quality controls at the mill assure tube as flawless as science can make it!

Insist on Chase Antimonial Admiralty!

CHASE WAREHOUSE STOCKS: Beaumont,* Houston,* Los Angeles, New Orleans, Tulsa**

*Handled by Standard Brass & Mfg. Co. **Handled by Vinson Supply Co.

Chase

BRASS & COPPER CO.

WATERBURY 20, CONNECTICUT • SUBSIDIARY OF KENNECOTT COPPER CORPORATION

The Nation's Headquarters for Brass & Copper

Atlanta Baltimore Boston Charlotte Chicago Cincinnati Cleveland Dallas Denver Detroit Grand Rapids Houston Indianapolis Kansas City, Mo. Los Angeles Milwaukee Minneapolis Newark New Orleans New York Philadelphia Pittsburgh Providence Rochester St. Louis San Francisco Seattle Waterbury

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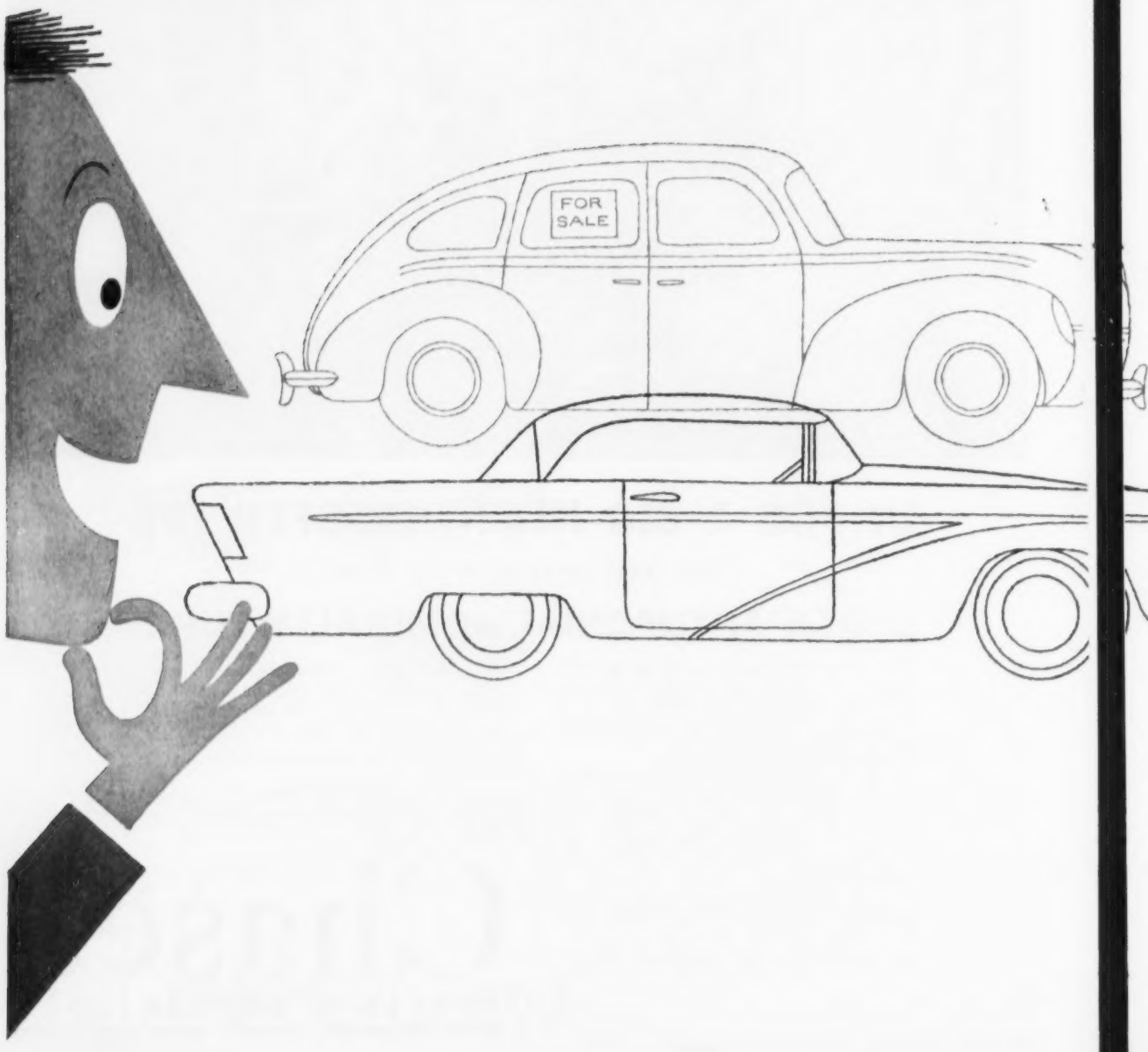
compressor designs also become



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New automobile designs with startling advances in styling and performance present their appearance every year. Engines considered to be the last word a few short years ago, have been scrapped in favor of new models possessing greater performance and stamina.

Isn't there also a continuing need for improved compressor designs and performance . . . don't they too become obsolete?

obsolete!

To avoid owning a *new* plant that is an antique *before* it starts up, be sure that you insist upon modern compressors.

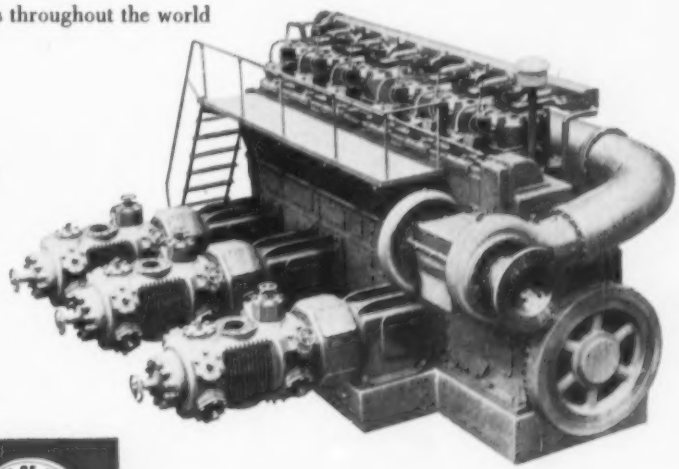
Clark is the only source of MODERN compressors that are specifically designed and built as turbo-supercharged units.

This means high power output—up to 65% more, without cutting into overload capacity or safety factor. Furthermore, a 10—15% reduction in fuel consumption plus a 40% saving in cooling cost is a direct result of turbo-supercharging.

Though Clark Model TLA and TRA Turbo-Supercharged compressors are modern designs, they have already been proved in numerous installations. They are built in 1100—3400 BHP models.

If you would like further details on the advantages of buying MODERN turbo-supercharged compressors to match your other up-to-date equipment and facilities, call your nearest Clark office or write for bulletins No. 134 and 145.

CLARK BROS. CO. • OLEAN, N. Y.
One of the Dresser Industries
Sales offices in principal cities throughout the world



Clark Model TLA-6 2000BHP Turbo-Supercharged, 2-cycle, gas-engine-driven compressor

CLARK®

ONE OF THE DRESSER INDUSTRIES

Turbo-Supercharged Compressors

For more data on advertised products, use Readers' Service Cards, last page.

He skipped the same 2 valves again today

Both are still in adjustment. Still no leaks, not even at the shank! Both are OIC plug valves. If he's curious enough to dismantle one, he'll see the OIC gland and O-ring construction that saves him time and cussing. It's different from other plug valves he's seen.

Three efficient seals prevent shank leakage on OIC plug valves. Concentric grooves machined into the gland liner form a "labyrinth" seal. The liner also retains an O-ring in contact with the plug's top face for a second positive seal. And resilient packing between gland and gland liner forms the third seal.

But the maintenance man measures design by *results*. OIC plug valves get his O. K. because they stay in adjustment a long time without leakage. However, if *you* are interested in the exclusive gland design and construction of these OIC plug valves, write for specification literature.

The Ohio Injector Company • Wadsworth, Ohio

OIC VALVES

FORGED & CAST STEEL, LUBRICATED
PLUG, BRONZE & IRON VALVES

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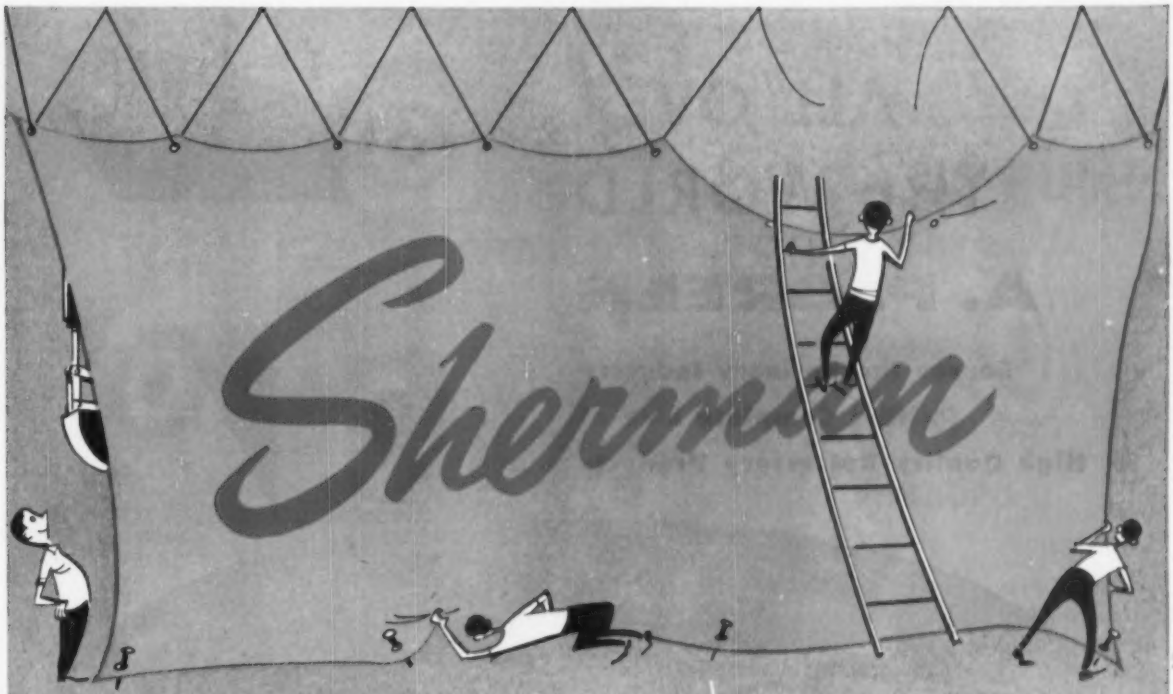

Don't Buy Any

Tractor Mounted Back-hoe

Until You See

The New 1956

Sherman Power Digger

at Your

Ford Tractor Dealer

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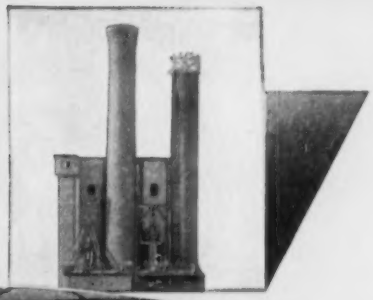
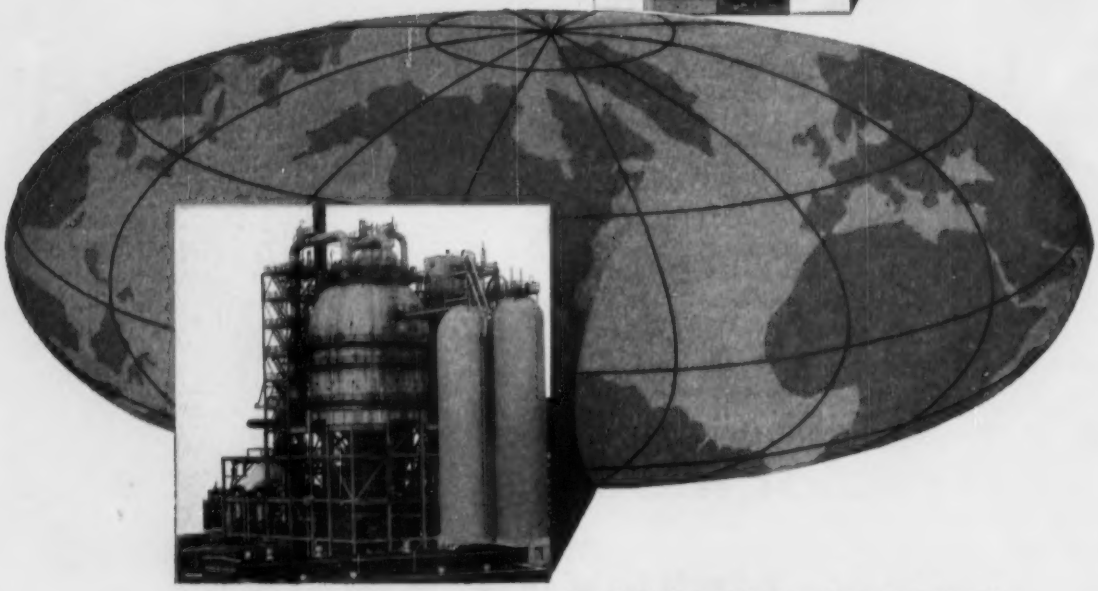
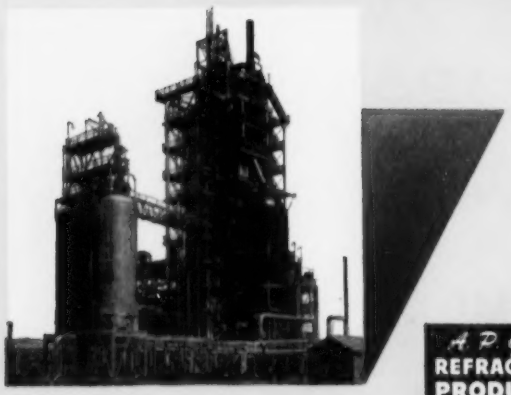
ALL OVER THE WORLD

A. P. GREEN

Serves the Refinery Industry with a Complete Line of High Quality Refractory Products







Throughout the world, the refinery industry relies on A. P. Green high quality refractories for dependable service in thermal and catalytic cracking units, heaters, boilers, stacks, etc.

A world-wide network of A. P. Green distributors is always ready to help you select the right refractories to do the best possible job . . . at the lowest cost. Regardless of location, A. P. Green refractories reach you quickly, safely, exactly as ordered.

A. P. Green
REFRACTORY PRODUCTS

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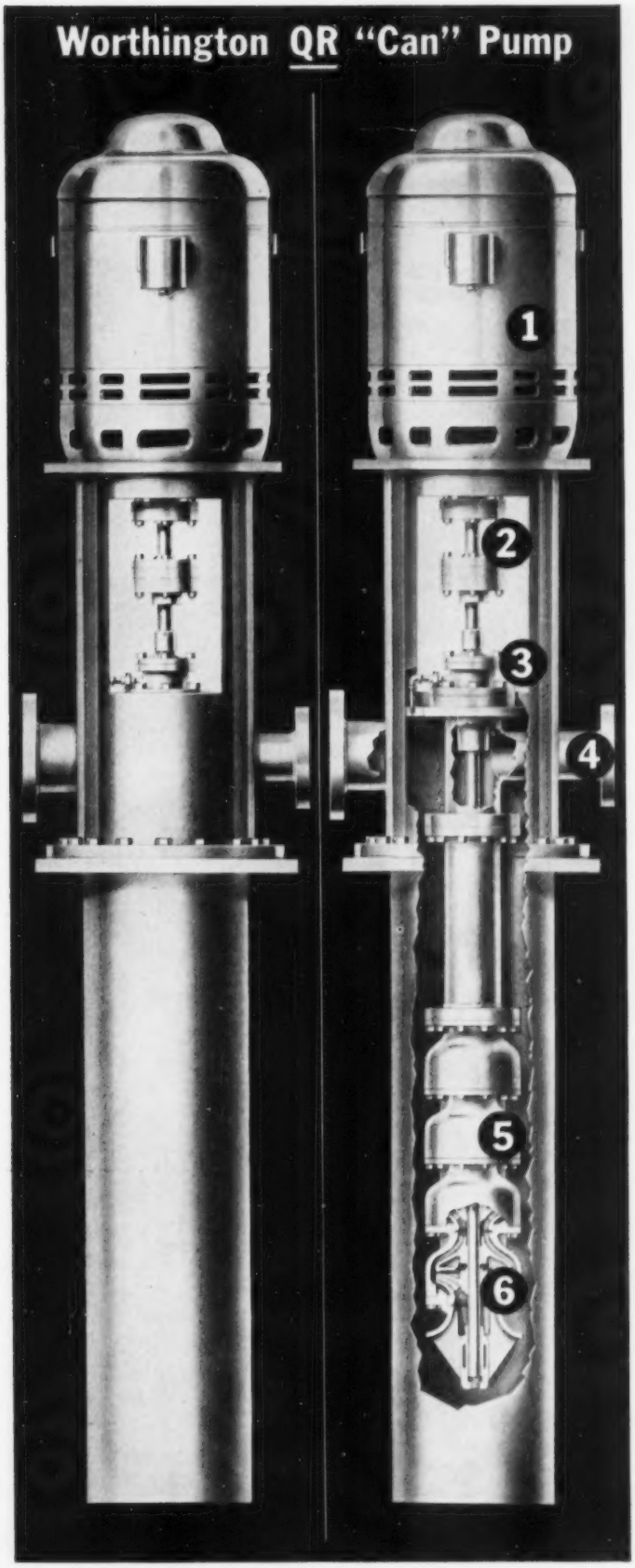
PLANTS: Mexico, Mo. • Woodbridge, N. J. • Sulphur Springs, Texas
In Canada: **A. P. GREEN FIRE BRICK COMPANY, LTD.**
Toronto 15, Ontario



WE'VE LICKED THESE REFINERY PUMP PROBLEMS:

Space

NPSH

Vibration

The toughest problems in vertical process pumps have been licked in the Worthington QR. Vertical construction requires minimum NPSH and space. Smoothest performance is assured by proper and conservative design of all running parts and nozzle heads. The quiet performance and long operating life of the QR are unequaled.

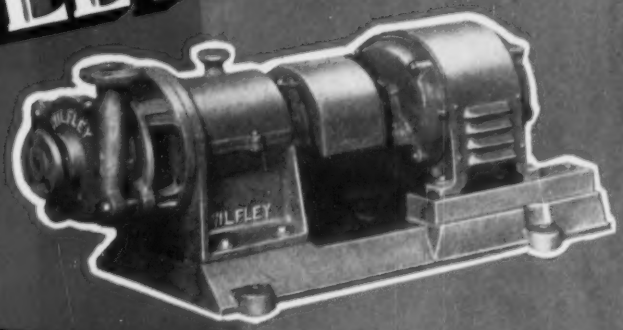
1. Driver can be a vertical solid shaft motor, vertical turbine, or right angle gear with shaft extension threaded and keyed for driver-half coupling.
2. Worthington rigid adjustable coupling. Spacer type shown furnished with mechanical seals to facilitate maintenance.
3. Available with mechanical seals or conventional box for packing with or without cooling.
4. Nozzle head and suction tank of fabricated steel.
5. Flanged type bowls of high strength cast iron with enclosed impellers and one piece shaft.
6. First stage impeller and suction bell designed for NPSH requirements.

In every point of operating efficiency, the Worthington QR Vertical Process Pump has proven superior. Talk to your Worthington engineer about your pump requirements. Worthington Corporation, A & SP-Pump Dept., Section C.6.2, Harrison, N. J.

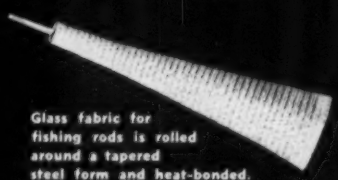
c.6.2

WORTHINGTON

From WILFLEY ACID PUMPS

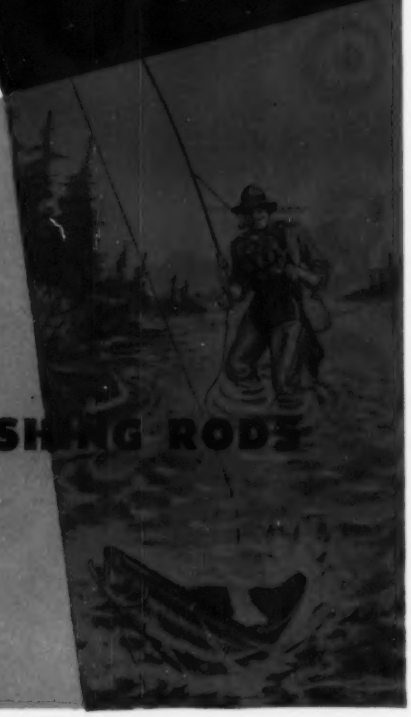


. . . to GLASS FABRIC



Glass fabric for fishing rods is rolled around a tapered steel form and heat-bonded. The form is then removed, creating the tubular glass rod blank.

Fishing rods are one of many glass products that originate in chemical plants where the basic ingredients are handled by Wilfley Acid Pumps. These highly efficient pumps operate without attention, delivering trouble-free performance on 'round-the-clock schedules. Let Wilfley reduce your pumping costs and increase production. Available with pumping parts of the machinable alloys as well as plastic to meet all requirements. Individual engineering on every application. Write, wire or phone for complete details.



Wilfley Acid Pump — "COMPANIONS IN ECONOMICAL OPERATION" — Wilfley Sand Pump

. . . to FISHING RODS

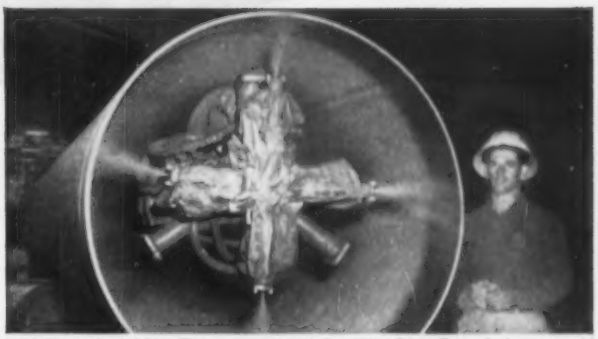
A. R. WILFLEY and SONS, INC.

DENVER, COLORADO, U.S.A.

New York Office: 1775 Broadway, New York City

EPON® RESIN does it!

New Internal Coating *protects pipelines against corrosion by crude oil, salt water, gas*



36" pipe to be laid by Transcontinental Gas Pipe Line Corp. being coated with *Copon*, containing Epon resin. *Copon* is manufactured by Coast Paint and Lacquer Co., Houston.

Stock of 36" pipe, lined with Epon resin coating, to be used by Transco.

HERE'S HOW...

INTERNAL CORROSION of gas pipe lines has long been a costly maintenance problem. The solution is an Epon resin coating that stands up to corrosives, that does not flake or peel off, that can be readily applied.

Such an Epon resin-based enamel is now going to work in nearly 300 miles of line for Transcontinental Gas Pipe Line Corp.

It's a *one-coat*, amine-catalyzed system which, cured at atmospheric temperatures, gives the performance of many baked finishes never before obtained with any other cold-cure coating. The Epon resin liner has complete adhesion to metals and extreme resistance to corrosion that keeps gas free of rust and pipe scale.

If you need a paint that lasts longer, that has excellent adhesion, resistance to abrasion and impact, ability to withstand a wide range of temperatures, humidity and corrosive atmospheres . . . ask for *Epon resin coatings*. Call on our sales offices for names of suppliers. Write for the full Epon coatings story in the brochure, "Planning to Paint a Pyramid?"

Epon resins are the epoxy polymers made exclusively by Shell Chemical Corporation.

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Chemical Partner of Industry and Agriculture

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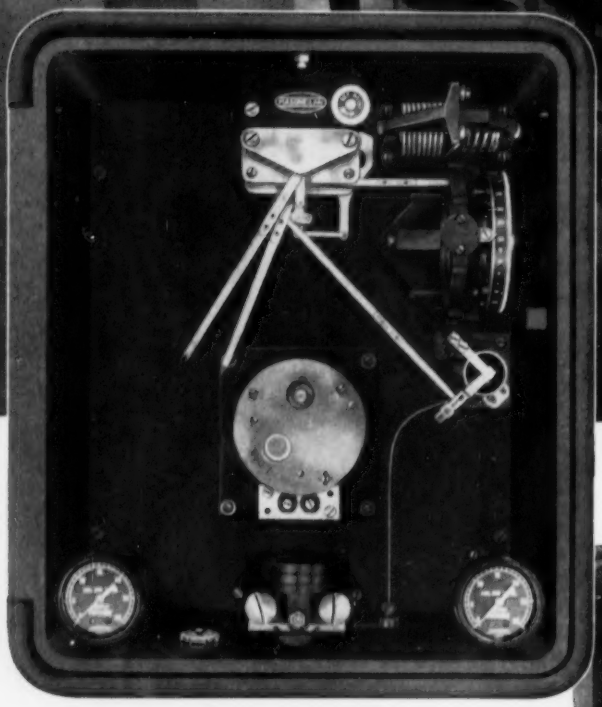
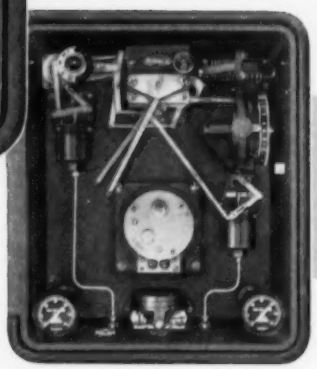
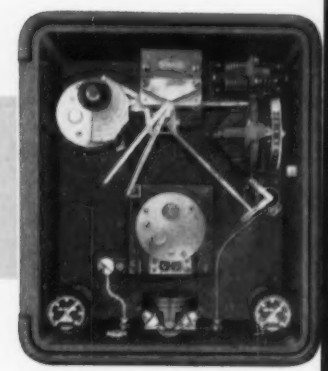


BASIC 60000
PNEUMATIC CONTROLLER

The basic controller provides versatility by combining proportional, differential-gap and on-off control, each with reversible action, in one instrument. Subassemblies may be installed to add the functions of reset and derivative. The exclusive gimbal unit enables you to select type of control and action and to adjust proportional band with one simple setting of the proportional band wheel. Large knurled knobs facilitate adjusting set point, reset rate and derivative time. All settings are made without disturbing the chart.



These are the functions you can perform. Pneumatic Set may be added to provide pneumatic positioning of the set point. Remote operation uses output pressure from another controller, a transmitter or a manually adjusted loading regulator.



Time Schedule may be added to position set point in accordance with a process-time schedule. Cam operation and chart record are in same instrument. Separate cam drive permits recording two or more cycles during one chart rotation.

THE VERSATILE 60000 ADVANCED LINE OF MASONEILAN CONTROLLERS

Complete series of pneumatic controllers features accuracy, dependability and simplicity — low over-all cost.

The answer to measuring or controlling your process can very likely be found in these Masoneilan Controllers. Many different functions can be performed, separately or in combination, using this advanced 60000 series. The features and flexibility are noteworthy:

- Unit subassemblies for independent servicing or interchange.
- Gimbal unit provides four combinations of primary and feedback motion.
- All air passages manifolded — with plug in connections for all pneumatic units.
- Modern design, tailored appearance — easy to mount and to service; recording or indicating types.

Select the right combination for your process control from the variety of models shown here. Then, plan to standardize on this advanced line — it will save you money on over-all instrument investment and pay-off in dependable performance. Contact the Masoneilan representative nearest you, or write:
Mason-Neilan Regulator Co., 1182 Adams St., Boston 24, Mass.

MASON-NEILAN MASONEILAN

Sales Offices or Distributors in the Following Cities: New York • Syracuse • Chicago • St. Louis • Tulsa
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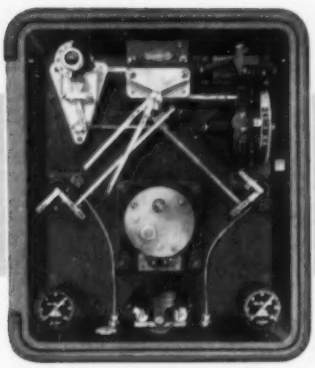
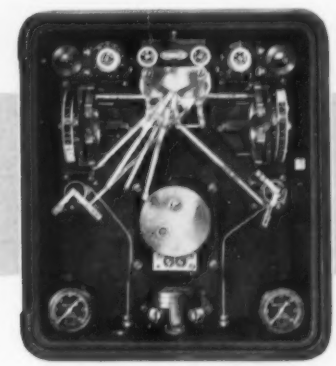
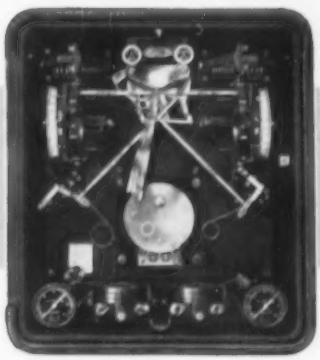


Differential mechanism is added to position set point by one of two similar variables between which a differential is being maintained by controller; or by one of two dissimilar variables between which the controller is maintaining a relationship.



The Dual Selector Controller consists of two complete control mechanisms which actuate a common pilot interchangeably, according to process requirements. It is used where two related variables may be controlled by a single valve.



Dual Controller has two complete units, including primary elements, in one case. Controls two similar or dissimilar variables and either or both may be recording or indicating. Duplex Controller has two mechanisms but one primary element. May be two controllers or controller and transmitter.

It's a "snap" to insulate Steam-Traced lines with SNAP*ON

. . . and it's a "snap", too, to insulate fittings, bends, couplings, cast iron pipe—any irregular piping.

Snap*On is a flexible, resilient, one-piece pipe insulation molded of fine glass fibers that actually snaps on the pipe. Made in sizes up to 33" I. P. S. and in sections 6 feet long, **Snap*On** cuts the cost of insulating big pipe to a minimum. Once on the pipe, **Snap*On's** flexibility prevents cracking under thermal contraction and expansion.

Snug fit and easy application are by no means the only reasons why you'll want to use **Snap*On** for both hot and cold piping. Thermally, it is superior to any other pipe insulation on the market. It's clean and dustfree. It's attractive, easy to finish. And **Snap*On** is as permanent as a pipe insulation can be, yet can easily be removed and reused. If you can't say as much for your present pipe insulation—

CALL YOUR LOCAL SNAP*ON DISTRIBUTOR TODAY
(HIS PHONE NUMBER IS IN THE ADJOINING COLUMN) **or**
WRITE FOR YOUR COPY OF NEW SNAP*ON BROCHURE

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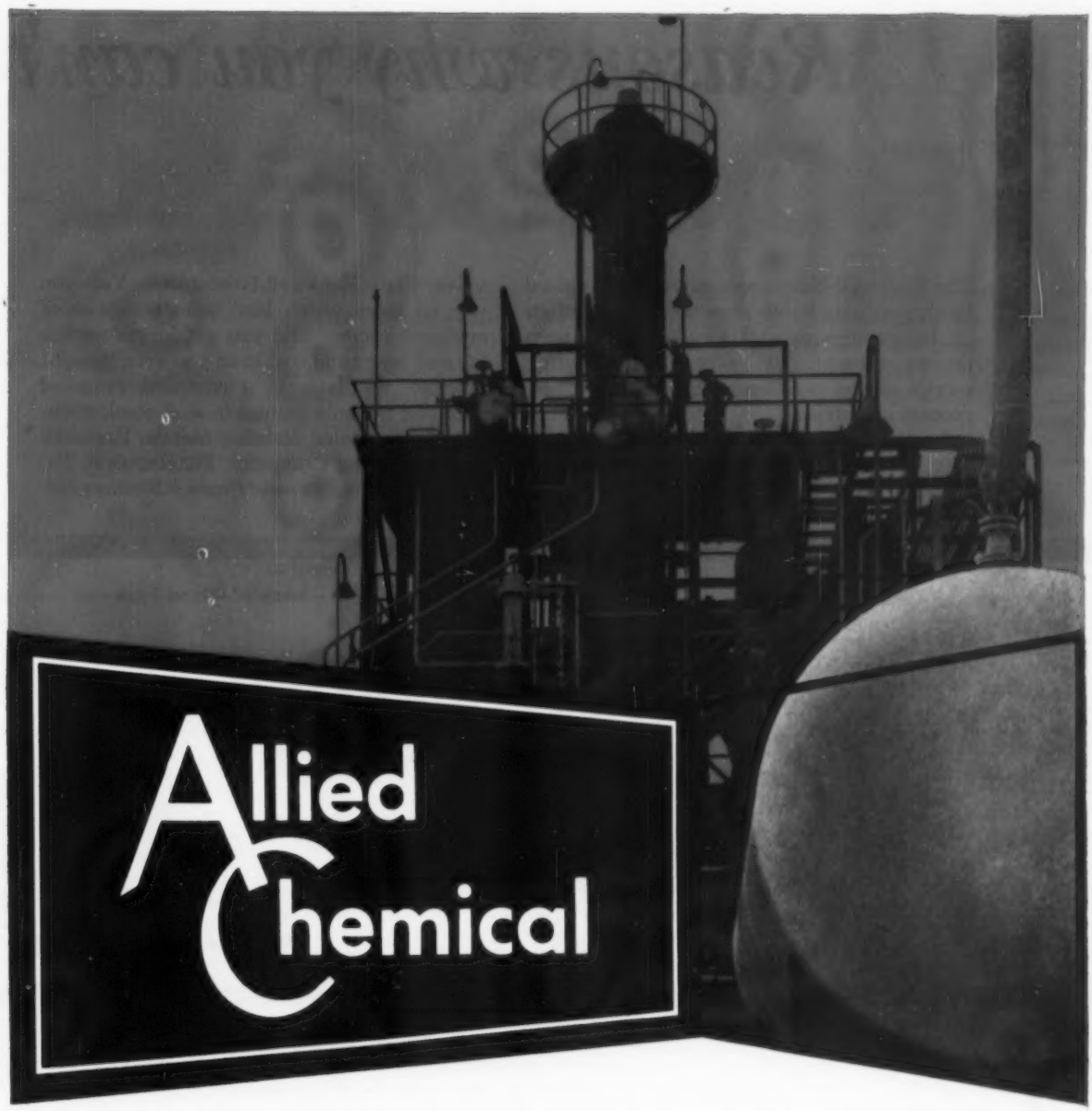
GUSTIN gb BACON

GUSTIN-BACON *Manufacturing Company*

242 W. 10th St., Kansas City, Mo.



ETHANOLAMINES

Treating gas with mono or diethanolamine? Allied's Orange, Texas, plant—most modern in the industry—can supply you with ethanolamines consistently above standard specifications. Shipments in tank cars, tank trucks or 55-gallon drums available from Orange, Texas. Nationwide stocks for delivery by tank truck and 55-gallon drums. Phone or write for samples, quotations, literature, technical service with no obligation.

Dept. EA 2-21-1

Allied Chemical — NITROGEN DIVISION

40 Rector Street, New York 6, N. Y.

Ethanolamines • Ethylene Oxide • Ethylene Glycols • Urea • Formaldehyde • U. F. Concentrate—85 • Anhydrous Ammonia • Ammonia Liquor • Ammonium Sulfate • Sodium Nitrate • Methanol • Nitrogen Solutions • Nitrogen Tetroxide • Fertilizers & Feed Supplements

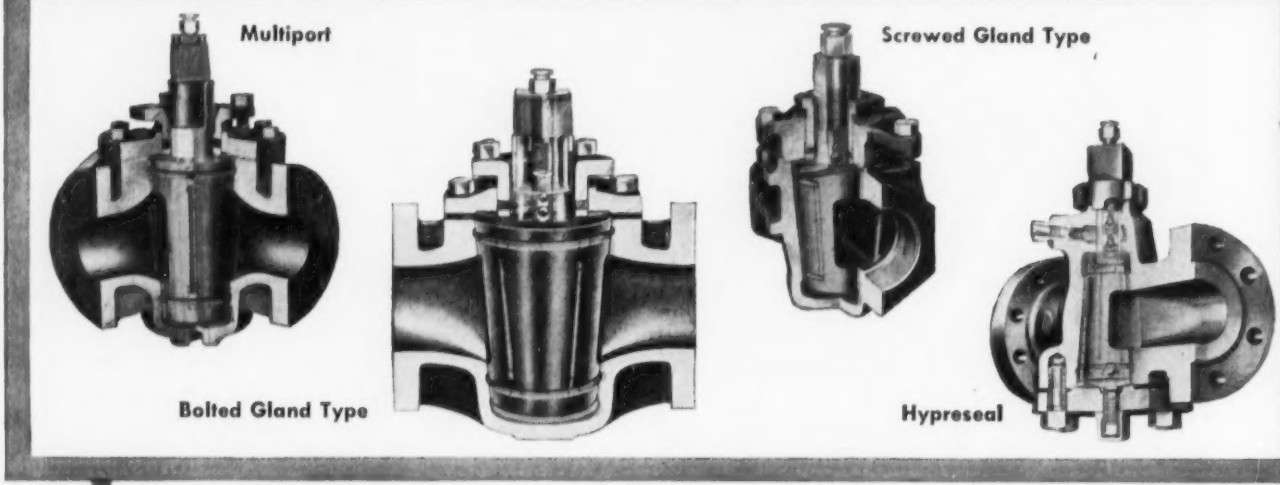
For more data on advertised products, use Readers' Service Cards, last page.

12 Reasons why you can't

ROCKWELL-

The Rockwell-Nordstrom valve—the *original* lubricated plug valve—has been copied often . . . but never equaled. Its leadership has been proven through 40 years of outstanding service in the petroleum, gas, chemical and process industries.

Look at the twelve Rockwell-Nordstrom valve features shown on these pages. They are the reasons why you can't buy a better valve than Rockwell-Nordstrom. Yet you pay no more (often less) than the price of ordinary valves—and you get longer service life and lower end cost than you ever thought possible. Available in a complete range of sizes and pressure ratings in semi-steel, stainless and corrosion resisting metals. Rockwell Manufacturing Company, Pittsburgh 8, Pa. *Canadian Valve Licensee: Peacock Brothers Ltd.*



1.

"Sealdport" Surrounds Ports with Lubricant Pressure.* **"Sealdport"** grooves at both sides of the plug give complete shut-off in either direction. In the closed position, the ports are completely surrounded by a sealing lubricant film. When turning the plug, grooves exposed to the line fluid ports are automatically disconnected.

*Registered Trademark, Rockwell Mfg., Co.

2.

Positive, Quarter-Turn, Rotary Action. The tapered rotary principle is the simplest, most positive valve action known. The taper of the plug and seat maintains an intimate working contact between the two parts at all times. Quarter-turn operation is from two to five times faster than ordinary valves.

3.

Unexposed Seats Eliminate Corrosion and Erosion. Corrosive and erosive elements can wreak havoc on exposed valve seats. But in a Rockwell-Nordstrom valve the seat is *never* exposed. Material touching the plug in the closed position is scraped off when the plug turns back to open position. Critical seat areas are completely sealed by pressurized lubricant.

4.

Simplest of All Valve Designs. There are only three basic parts comprising the standard Rockwell-Nordstrom valve—(1) body, (2) cover, (3) plug . . . the only movable member. It is a mechanical axiom that "the fewer the parts, the fewer the repairs."

buy a better valve than

Nordstrom

5.

Full Floating Hypreseal Plug. The Hypreseal stem is entirely independent of the tapered valve plug except by a floating equalizer ring. The stem has a long threaded engagement in the neck of the valve body to carry the outward line pressure thrust and seals against leakage without excessive friction of deep stuffing boxes. The stem thread is lubricated and sealed by lubricant from the chamber surrounding the equalizer. Injection type packing prevents escape of lubricant around the stem.

6.

Resilient Plug Seating. In Rockwell-Nordstrom valves the plug has a small, but highly important, degree of resiliency. This prevents binding, allows the lubricant "jacking" action to function properly, and avoids unseating which would result in loss of lubricant, seat exposure or damage.

7.

Shoulder Seal. The shoulder type of stem seal is used in preference to conventional stuffing boxes. It is compact, produces a minimum of friction, and combines the functions of stem seal and thrust bearing.

8.

Smoothly Contoured Passages. The interior of Rockwell-Nordstrom valves presents an unbroken line devoid of crevices for any lodgment of line contents. Flow characteristics are designed for minimum pressure drop.

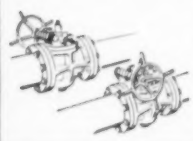
9.

Repackable under Pressure. The Rockwell-Nordstrom Hypreseal is the only valve that can be repacked under any line pressure and in any position. This eliminates shutdown of the line. No packing gland or stuffing box is used.

10.

Adjust or Lubricate under Pressure. Rockwell-Nordstrom valves are the only type of valve that can be fully adjusted and lubricated in service. In any operating position the plug can be jacked from its seat by a few turns of the lube screw or by injections with a lubricant gun.

11.



Flow Either Way at Any Differential. Rockwell-Nordstrom valves are not restricted to one-way flow. There is no single "pressure side" requiring a specified end to go on the upstream side. Since the Rockwell-Nordstrom non-wedge action and transfer of plug pressure to the lubricated seat allows *operation at any pressure differential* within its range, galled or frozen valves and by-passes are eliminated.

12.

No Bonnet Cavity—Saves Weight and Space. Compare the overall dimensions of Rockwell-Nordstrom valves with any other type of valve and note the saving in space. For most Rockwell-Nordstrom valves the space occupied is little more than the diameter of the line pipe flanges.

ROCKWELL-Nordstrom VALVES

Lubricant Sealed for Positive Shut-Off

40th YEAR *of lubricated plug valve leadership*

Scarcity Accents the Importance of Quality . . .

So You Have an Important Stake in J&L Research

Every man who buys or uses or is interested in the use of A.P.I. Tubular Products can observe the results of J&L research.

It is reflected in the adaptability and useful life expectancy of every length of J&L pipe, seamless or welded.

It is reflected in the excellence of the technical services of J&L Supply Men actively and enthusiastically interested in helping you get maximum dividends from your pipe investments.

J&L PIPE

J&L STEEL

Jones & Laughlin

SUPPLY DIVISION – Tulsa

SERVING THE UNITED STATES AND CANADA

3-1

TAXE$ . . . earned by brick

If you own securities . . . if you're paid a salary . . . if you earn commissions . . . no matter how you make your income, the starting point is brick. Refractory brick.

Refractories, the industry behind industry. Refractories that contain and control flame . . . the flame that produces metals, glass, paper, rubber, oil, cement, power, transportation. Everything that's made or moved requires them.

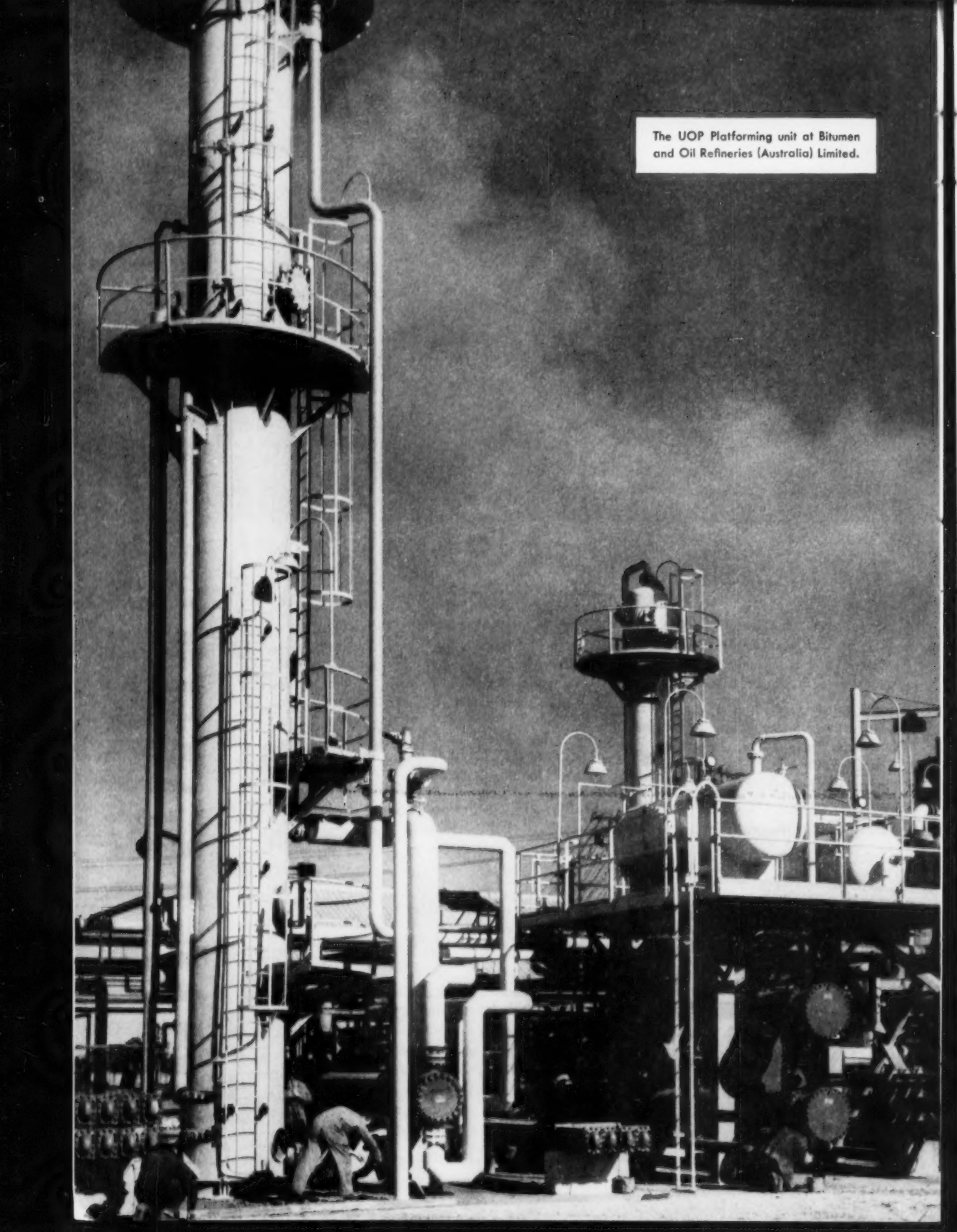
But those requirements vary . . . vary over a vast range of applications. To provide them in almost infinite variety and enormous quantity, Grefco employs extensive research, maintains the world's most modern refractories laboratory, and supplies a Complete Refractories Service from strategically located plants, both here and abroad, that draw on the world for materials.

A Complete Refractories Service
GENERAL REFRACTORIES COMPANY
Philadelphia 2

SEND FOR THE MOTION PICTURE: THE GREFCO STORY

It is a beautiful 16 mm. motion picture in full color and sound which relates the fascinating and little understood story about the refractories industry... *the industry behind industry.* Viewing time is 26 minutes. If you would like to show it to executive, employee, social, church or other groups, a request on your letterhead is all that is necessary. Address General Refractories, Philadelphia 2.

GENERAL REFRACTORIES



The UOP Platforming unit at Bitumen and Oil Refineries (Australia) Limited.

Australian Refiner Reports on 3 Years Operation of UOP Platforming Unit

By E. R. Griffin
General Manager
Bitumen and Oil Refineries (Australia) Limited
Matraville, New South Wales

BORAL has the distinction of being the first refiner outside the American continent to install a UOP Platforming unit, and in more than three years it has operated absolutely trouble-free. Since it went on stream in July, 1952, it has been shut down only for inspections and for cleaning or changing catalyst. In our opinion, this remarkable record was not only achieved because of careful operating control, but reflects, as well, the sound processing techniques of operation provided through the application of UOP fundamental basic research and a well designed and engineered process.

E. R. Griffin

The unit at our refinery set a world record for catalyst life, the first charge having lasted for nearly two years. It was dumped on July 1, 1954, having processed 253 barrels of charge per pound of catalyst. A Platformate yield of 94.1 per cent, based on reactor charge, was realized over the entire run and at the time of dumping, it was still making the 72 octane (motor method) standard grade of motor fuel called for in the local market with the addition of only 1.2 cc. TEL. Making such an octane proved to be an easy job for the Platformer even though Middle East naphthas, processed in the unit, generally are among the least desirable charge stocks for catalytic reforming operations.

Now, the standard grade motor fuel has been increased to 79-81 (research), and a premium grade of 90 research octane has been introduced, both of which are being produced by the Platforming unit without difficulty.

The decision to install the Platforming unit, which had an original design capacity of 1,500 barrels per stream day, came after an exhaustive investigation in which it was determined that this process would give us the flexibility we needed in the selection of a charge stock. Our refinery in Sydney then consisted of a 5,000 B/SD two-stage distillation unit and an asphalt converter unit. A synthetic crude oil, to which was added a small quantity of cracked gasoline, was obtained from the Persian Gulf area for processing into Diesel oil, fuel oil and various grades of asphalt. The gasoline was distilled and sweetened for sale in the local market.

Economics dictated that the processing of whole crude would be more profitable than running synthetic crude because low octane straight run gasoline obtained from whole crude could be upgraded in octane by catalytic reforming with much higher yields than could be obtained by conventional thermal reforming, which was expensive and unsuitable for our requirements.

Having decided to install Platforming, we asked UOP to send an engineer to Australia to assist us in planning for the construction of the unit. Engineering, detailed drafting and purchasing of items not readily obtainable in our country for erection of the Platformer were handled by UOP, which licensed the process. Refinery personnel built the unit.

We decided in 1954 to expand our refining facilities and improve the quality of our other petroleum products. After discussions with UOP on the best course to follow, we concluded that the Unifining process would be most adaptable to our needs. Universal was requested to prepare the engineering and detailed drafting and to purchase hard-to-get items as well as to prepare the design and engineering for revamping the Platformer to increase its capacity to 2,500 B/SD, and to prepare the process designs for a 10,000 B/SD topping plant.

Exhaustive work in Universal's laboratories resulted in the design of a "tailor-made" Unifining unit which processes a combination of Diesel fuel and aromatic light oil produced from an oil gas plant located in Sydney. The Unifining unit has made BORAL one of the first refiners in the world to offer Diesel fuel purified by the use of hydrogen.

In conclusion, we would like to say that our association with UOP not only has enabled us to keep abreast of the most modern refining techniques, but it has made available to us technical "know-how" which has proved invaluable.

DOWN UNDER
BORAL USES UOP
PLATFORMING TO PROVIDE
AUSTRALIAN MOTORISTS
WITH HIGH QUALITY
MOTOR FUEL

designed, engineered and licensed by

UNIVERSAL
OIL PRODUCTS
COMPANY

30 ALGONQUIN ROAD,
DES PLAINES, ILL., U.S.A.

Forty Years Of Leadership
In Petroleum Refining Technology

more and more refineries find new KEY type 5000 fitting right for their heaters...

These outstanding companies among many now served by newly developed refinery fitting...

CANADIAN OIL COMPANIES, LTD.
THE DERBY REFINING CO.
EASTERN STATES PETROLEUM CO., INC.
ESSO STANDARD OIL COMPANY
GULF OIL CORP.
LEONARD REFINERIES, INC.
MAGNOLIA PETROLEUM CO.
RICHFIELD OIL CORP.
SOCONY MOBIL OIL CO., INC.
STANDARD OIL COMPANY OF CALIFORNIA
THE TEXAS COMPANY
TIDE WATER ASSOCIATED OIL COMPANY

Introduced recently, this new Type 5000 Fitting by Key Co. has achieved almost overnight recognition and acceptance by the refinery industry.

Most prominent feature of the Key 5000 Type Return Bend Fitting is its simplicity. With two series available of nine fittings each, the 18 fittings contain only 26 parts instead of the conventional 72 in other fittings of this type.

This reduction in the number of parts—made possible by the fittings' high degree of interchangeability—permits substantial lowering of inventory and inventory cost.

Write today for detailed information and prices on this unique fitting. All parts, exclusive of the body casting, are available for immediate shipment from stock.

Key company

SINCE 1916... MANUFACTURERS AND DEVELOPERS OF PRODUCTS FOR HIGH TEMPERATURES AND PRESSURES

P. O. BOX 494-E EAST ST. LOUIS, ILLINOIS

A DIVISION OF O.C.F. INDUSTRIES INCORPORATED

DISTRICT OFFICES: NEW YORK • CLEVELAND • CHICAGO • TULSA • HOUSTON • LOS ANGELES

STRUTHERS WELLS

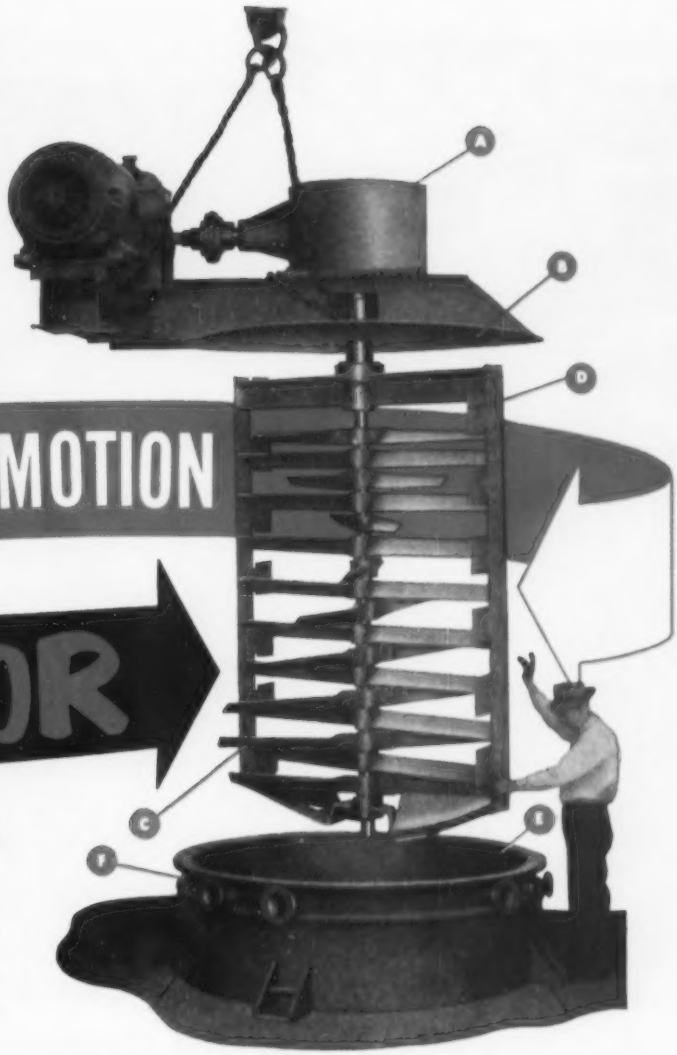
MIXING VESSEL

FOR PROCESSING

HEAVY VISCOUS

MATERIALS

Struthers Wells DOUBLE MOTION AGITATOR



- **A** — **Double motion drivehead, an exclusive Struthers Wells design. Horsepowers from 2 to 150. Furnished with sealing devices when used on pressure kettles.**
- **B** — **Kettles can be open flat top, or dished and flanged closed top for working pressures as high as 300 lbs.**
- **C** — **Sweep and paddle arms are pitched to create flow of material throughout kettle—preventing stratifying of the mix. Scraper frame and paddle arms can be of welded design or bolted for easy removal when vessel is equipped with a cover.**
- **D** — **Scraper blades are advanced hinged type, which insures positive scraping action on 98% of the inside surface of mixer.**
- **E** — **Mixer can be fabricated of steel or special alloy to meet specifications.**
- **F** — **Kettles furnished with jacket or unjacketed for possible direct fire application.**

For speed, economy and dependability—specify the Struthers Wells Double Motion Mixing Vessels—for processing greases and other heavy viscous materials. Our extensive machine shops and fabricating facilities—combined with years of engineering experience in designing all types of agitating vessels, enable us to furnish mixing equipment for any material, to your most rigid specifications.

For intricately designed or standard mixing equipment—*think first of Struthers Wells.*

STRUTHERS WELLS PRODUCTS

PROCESSING EQUIPMENT DIVISION

Crystallizers . . . Direct Fired Heaters . . . Evaporators . . . Heat Exchangers . . . Mixing and Blending Units . . . Quick Opening Doors . . . Special Carbon and Alloy Processing Vessels . . . Synthesis Converters

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MACHINERY DIVISION

MACHINERY for Sheet and Structural Metal Forming . . . Tangent Benders . . . Folding Machines . . . Roller Table and Tumble Die Bending Machines . . . Press Brakes . . . Punching and Notching Machines . . . Forming Dies

STRUTHERS WELLS *Corporation*

Struthers Wells

WARREN, PA.

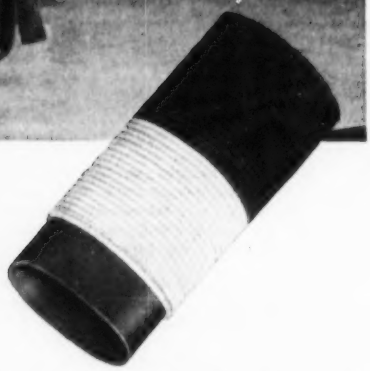
PLANTS AT WARREN, PA. AND TITUSVILLE, PA.

Offices in Principal Cities

For more data on advertised products, use Readers' Service Cards, last page.

Quaker

Here's why this PETROCHEM fire hose is on guard throughout this D-X Sunray refinery



Get acquainted with your Quaker-Quaker Pioneer distributor. You'll find him of real help—not only for your regular needs—but also in emergency situations requiring extra fast supply. Write for free brochure and name of your nearest distributor.

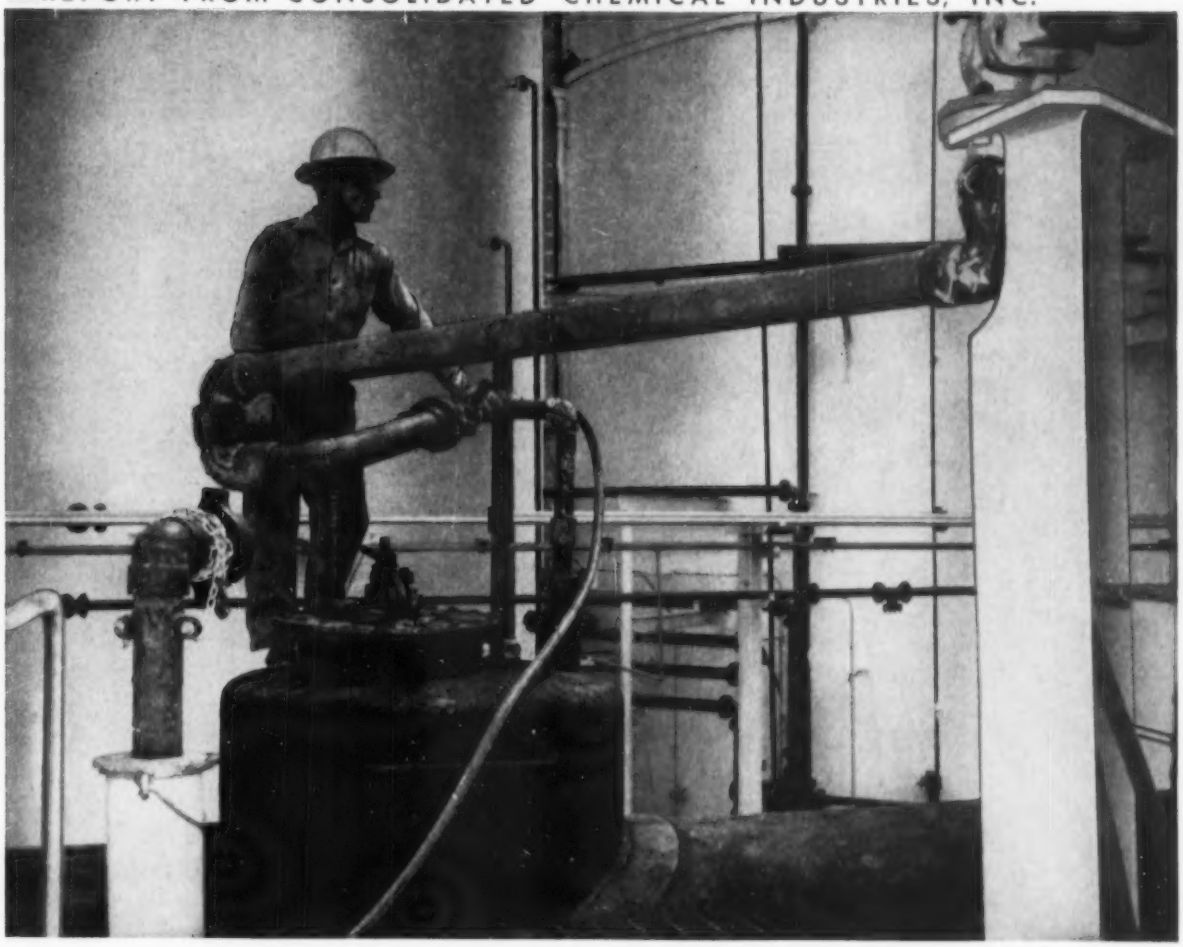
This hose does *more* than fight fire. It fights off deterioration by oil and chemicals, stands up to abrasion, resists weather and functions safely under high pressure. Why? Because its oil-resistant Neoprene tube is enclosed in tough, wear-defying *Du Pont Dacron* impregnated with oil-proof Neoprene . . . this provides a tough, light, flexible hose, resistant to oil, both inside and out. Actually this hose is so strong that it can take pressures up to 500 lbs. and temperatures up to 300°F. . . . and so flexible that you can actually knot it. Easy to store, too! Either coiled or folded it takes little space.

These are some of the reasons why D-X Sunray's Oklahoma refinery has this hose . . . the first made for oil and chemical industries, at all fire stations . . . and why it will pay you to consider it in your safety planning. Complete Quaker-Quaker Pioneer line includes hose for every purpose, belting, packing and moulded rubber for every use.

DIVISIONS OF HKP H. K. PORTER COMPANY, INC.

H. K. PORTER COMPANY, INC.
QUAKER RUBBER DIVISION
Philadelphia 24, Pa.
QUAKER PIONEER RUBBER DIVISION
San Francisco 7, California

REPORT FROM CONSOLIDATED CHEMICAL INDUSTRIES, INC.



Give your product a SAFE SENDOFF

Use CHIKSAN LOADING ARMS

Consolidated Chemical Industries is safety conscious! They use Chiksan loading arms for tank car loading of sulphuric acid.

To assure complete safety in your loading operations, CHIKSAN manufactures loading arms and ball bearing swivel joints from the same materials used in the piping systems. Steel, malleable iron, nickel-bronze, stainless steel and special alloys are used . . . meeting most chemical requirements. CHIKSAN ball-bearing swivel joints speed the loading and unloading of both liquids and gases . . . safely. Send for your copy of our free catalog which shows complete CHIKSAN lines and standard loading arm designs.

Chiksan Swivel Joints rotate 360° in 1, 2 and 3 planes, handling air, hydraulics, fuels, oils, water and other fluids.

WRITE DEPT. 32 FOR CATALOG

CHIKSAN

A SUBSIDIARY OF FOOD MACHINERY AND CHEMICAL CORPORATION

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CHIKSAN COMPANY, Brea, California • Chicago 3, Illinois • Newark 2, New Jersey • Well Equipment Mfg. Corp., (Division) Houston 7, Texas • Chiksan Export Co., Brea, California; Newark 2, New Jersey • Chiksan of Canada, Ltd., Edmonton, Alta.

For more data on advertised products, use Readers' Service Cards, last page.

Pick a card ...any card

• • • On it you'll find the answer to a certain refinery tubing problem. These 24 different steel tube analyses are the result of over 60 years of work and research in the refinery field. Each analysis has been developed to counteract specific refinery conditions ranging from corrosion to high pressures and temperatures. Each analysis has been tested again and again in actual refinery service so that our engineers know its exact capabilities and limitations. In addition to the two dozen analyses shown here, other chemical compositions are available in tubular products, and a wide variety of temperature problems are presently under study.

So pick a card—the analysis you think will meet your refinery tubing needs. But, to be sure before you order, contact us. We have a technically trained Mill Service Force available to you for technical and operating assistance in meeting your tubular requirements. This Force is also available for consultation in the field. We might be able to save you money by selecting a better alloy, at lower cost, to meet your problem. Service is as much a part of our business as is selling pipe. Let us hear from you.

★ ★ ★

Write to National Tube Division, United States Steel Corporation, 525 William Penn Place, Pittsburgh 30, Pennsylvania.

TWO DOZEN DIFFERENT NATIONAL TUBE ANALYSES:

Carbon	8 Cr, 1 Mo
Carbon, ½ Mo	9 Cr, 1 Mo
1 Cr, ½ Mo	12 Cr
1¼ Cr, ½ Mo	12 Cr, Al
2 Cr, ½ Mo	17 Cr
2¼ Cr, 1 Mo	18-8
2½ Cr, ½ Mo, ¾ Si	18-8 Ti
3 Cr, 1 Mo	18-8 Cb
5 Cr, ½ Mo	18-8 Mo
5 Cr, ½ Mo, 1½ Si	25-20
7 Cr, ½ Mo	3½ Ni
8 Cr, ½ Mo	5 Ni

NATIONAL TUBE DIVISION, UNITED STATES STEEL CORPORATION, PITTSBURGH, PA.
(Tubing Specialties)
COLUMBIA-GENEVA STEEL DIVISION, SAN FRANCISCO, PACIFIC COAST DISTRIBUTORS • UNITED STATES STEEL EXPORT COMPANY, NEW YORK

USS **NATIONAL SEAMLESS PIPE AND TUBES**

WELDS WITHOUT WELDS

UNITED STATES STEEL

THE VALVE THAT LIKES TO BE COMPARED

IN SERVICE

K&M design features and production standards prove out...

Kieley & Mueller always invites comparison . . . because comparison alone points up the superior value of K&M Diaphragm Control Valves.

First, *compare response* of the K&M fully molded diaphragm combined with the highest power factor in the industry. *Compare the safety* and convenience of the all steel topworks. And, *compare materials,* part for part . . . K&M furnishes—as standard without extra cost—more parts manufactured of high-finish costly alloys.

Then, compare K&M valves in service . . . *side by side* with any other diaphragm control valve.

Keep your own maintenance records . . . and your own records will tell the K&M story.

Send for your copy of the K&M Valve Data Catalog, Bulletin CV-53.

78th Anniversary... Oldest U.S. Pressure and Level Control Valve Manufacturer

diaphragm control valves

KIELEY & MUELLER, INC.

64 Genung Street • Middletown, New York

K&M

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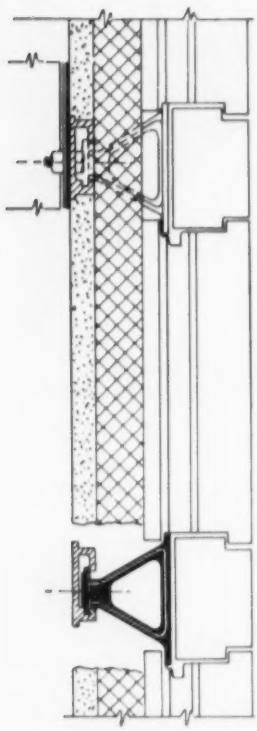
INTRODUCING
BIGELOW-LIPTAK'S
BI-MET*

Insulated Furnace Walls For High Temperature Applications

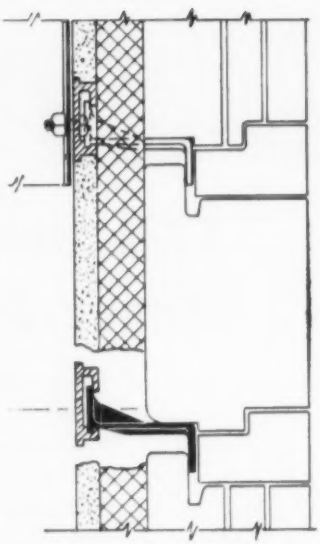


The 4½ inch wall

Here's a job-proven idea which is designed to pare the costs of suspended furnace enclosures. It's used when temperatures are going to be high and when expensive special alloy supporting castings must be used.

Two different castings are used. The first, an alloy clip casting is embedded in the tile where temperatures are highest. This, in turn, is fastened to a standard cast iron support. The design permits the most economical use of costly alloys.

This is a Bigelow-Liptak BI-MET wall and it is another example of B-L's efforts to produce quality furnace enclosures at lower and lower initial costs. Remember: a suspended enclosure for a boiler, a refinery heater, or any other type of installation, will *last longer, have less down time for repairs.* That makes a suspended job the cheapest in the long run. Want to cash in on savings like these? Contact the B-L office nearest you.



The 7 inch wall

*PATENT APPLIED FOR

BIGELOW-LIPTAK *Corporation*

AND BIGELOW-LIPTAK EXPORT CORPORATION
2550 WEST GRAND BOULEVARD, DETROIT 8, MICHIGAN

UNIT-SUSPENDED WALLS AND ARCHES

In Canada: BIGELOW-LIPTAK OF CANADA, LTD., *Toronto, Ontario*

ATLANTA • BOSTON • BUFFALO • CHICAGO • CLEVELAND • DENVER • HOUSTON • KANSAS CITY, MO. • LOS ANGELES • MIAMI • MINNEAPOLIS • NEW YORK • PHILADELPHIA • PITTSBURGH • PORTLAND, ORE. • ST. LOUIS • ST. PAUL • SALT LAKE CITY • SAN FRANCISCO • SEATTLE • TULSA • MONTREAL • SAULT STE. MARIE, ONT. • VANCOUVER • WINNIPEG

For more data on advertised products, use Readers' Service Cards, last page.

The "Precious Plus" that didn't appear on the Blueprints

You *see* reactors, vessels, towers and piping — and they have the familiar look of any other Paraxylene and Udex plant. But what you *don't see* — what blueprints cannot show — is the "Precious Plus" that earmarks this "a BMC project".

At the time BMC was awarded the design and construction contract, the client had *firm* commitments to ship paraxylene within a fixed time period . . . a time period that would require tight scheduling — even for *conventional* design and construction.

But there was nothing ordinary about *this* Paraxylene plant. It called for a unique crystallizing process — developed by BMC but never before used — that would require time-consuming creative engineering.

Working under almost prohibitive time pressures, a BMC Task Force — with the *Key Man* in charge — tackled the job. There was no waste motion in engineering. Drafting geared itself to a back-breaking schedule. Equipment orders were placed early. Usual "bugs" were anticipated — and avoided.

The plant went "on-stream" ahead of the client's *fixed* schedule . . . and first shipments were on their way well in advance of the contract commitments. Cost? Substantially below the estimate despite the emphasis on speed.

You can't see it . . . you pay nothing for it . . . but the "Precious Plus" included in this project is a part of every BMC proposal. Many leading petroleum and petrochemical companies have found it a distinct advantage in getting better plants, faster and at a lower cost. How else explain the unusual growth BMC is enjoying?

The Udex and Paraxylene Plants described here were designed and constructed for Sinclair Refining Company, Marcus Hook, Pa.

+ BMC's *Key Man* operation is unique among major contract engineering firms. The BMC man who submits your proposal is *always* a BMC principal . . . *always* the Key Man heading up the Task Force responsible for the execution of your job. Clients tell us "This is the BMC difference that makes the difference."

BMC

BADGER MANUFACTURING COMPANY

230 Bent Street, Cambridge 41, Mass.
60 East 42nd Street, New York 17, New York

ENGINEERS • CONTRACTORS • DESIGNERS • MANUFACTURERS

ÆSOP'S FABLES No. I

Foxy Fox was quite hungry and thirsty when he stole into a vineyard with its luscious grapes hanging high on a trellis. Again and again he jumped and snapped, only to fall short each time. Finally, fatigued, he sat back on his haunches and muttered: "Well, I didn't want those grapes anyhow . . . they're probably sour!"

Moral:

It is easy enough to say "sour grapes" to that which we cannot get.

. . . but, there's no cause for this to happen when it comes to the *availability* of famous ADAMANT High Temperature Fire Brick Cement . . . or any others of the popular ADAPRODUCTS Line of Refractories. We have Distributors located in key spots throughout the country . . . in Canada, too! Consult the yellow pages of your 'phone directory . . . or, write us for the name and address of your nearest BOTFIELD Distributor.

Botfield

ESTABLISHED 1907

REFRACTORIES

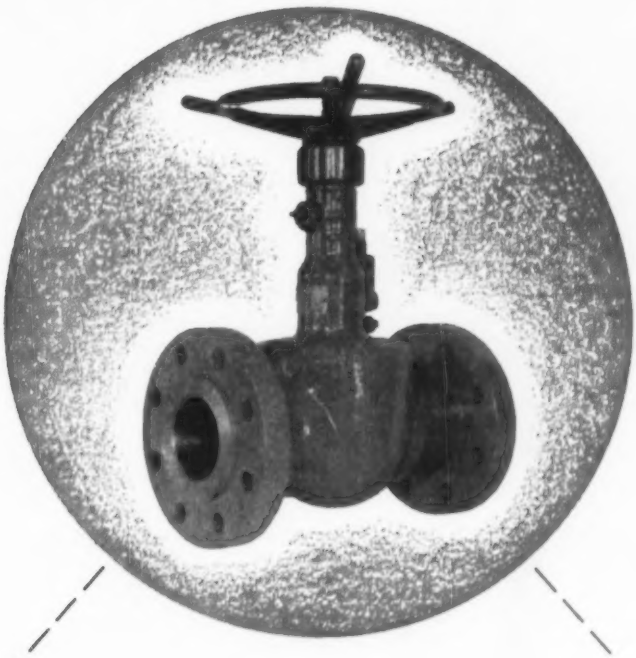
ADAMANT and other ADA products

swanson and clymer sts.
philadelphia 47, penna.

FORGED STEEL

ORBIT ASA CLASS FORGED STEEL VALVES GIVE TROUBLE-FREE PERFORMANCE IN THE FOLLOWING SERVICES . . . .

1. HYDROGEN
2. AMMONIA (Liquid or Gas)



3. HYDROCARBONS (Liquid or Gas)
4. BUTADIENE

WELDED BONNET CONSTRUCTION

RISING STEM

No Lubricant Required for Tight Shut-off.

This feature is important on hydrogen lines of platforming units where contamination carry-over from valve lubricants can lower catalyst efficiency.

Available in both Carbon and Stainless trim: Full Round Opening in sizes 1" to 4" Flanged and Screw End. Venturi Opening; Flanged only, sizes 2" to 6".

See 23rd Edition of Refinery Catalog or write for Catalog 56-C.

ORBIT VALVES ®

ORBIT VALVE COMPANY

P. O. BOX 699 *(For over 40 years)* TULSA 1, OKLAHOMA

For more data on advertised products, use Readers' Service Cards, last page.

CONISTON

complete chemical plant . . .

from origination of flow plans, to construction and operation is provided by the specialised Coniston service. The organisation provides the technical experience of leading engineers at every phase of the contract, with facilities for detailed analysis of processes and complete co-ordination of all detail studies. If you have new plant in mind a sound beginning is to consult Coniston who will ensure a successful conclusion.

THE CONISTON COMPANY

(CONTROLLED BY THE CONISTON ENGINEERING CO. LTD.)

EAGLE HOUSE, HIGH STREET, WIMBLEDON, S.W.19

TELEPHONE: WIMBLEDON 8521 (PBX)

GRAMS: CONISTON TOOT LONDON (INLAND) CONISTON LONDON (OVERSEAS)

*"TUBE-TURN" and "tt" Reg. U.S. Pat. Off.

To help you in the fight on corrosion...

FIBRES of inert iron silicate distributed throughout high-purity iron make wrought iron *tough* and *corrosion-resistant*... hence a desirable piping material for many applications where corrosion is a factor. In this material too, the "TUBE-TURN"* line of welding fittings is *complete* . . . all types, sizes and schedules for every job in wrought iron piping.

Here is another reason it pays to specify this leading brand! You get exactly what you need from more than 4000 items in all piping materials . . . available *promptly* from your nearby Tube Turns' Distributor. He can save you purchasing time and delivery time, and give you more for the dollar with TUBE-TURN Welding Fittings and Flanges.

TUBE-TURN Welding Fittings and Flanges are made in U. S. A.
They meet *all* U. S. piping code specifications.

The complete line... for all your needs

CARBON STEELS
STAINLESS STEEL
CHROME-MOLY STEELS

WROUGHT IRON

ALUMINUM
COPPER
BRASS
MONEL METAL
INCONEL
NICKEL

Available from your nearby TUBE TURNS' Distributor

TUBE TURNS LOUISVILLE 1, KENTUCKY

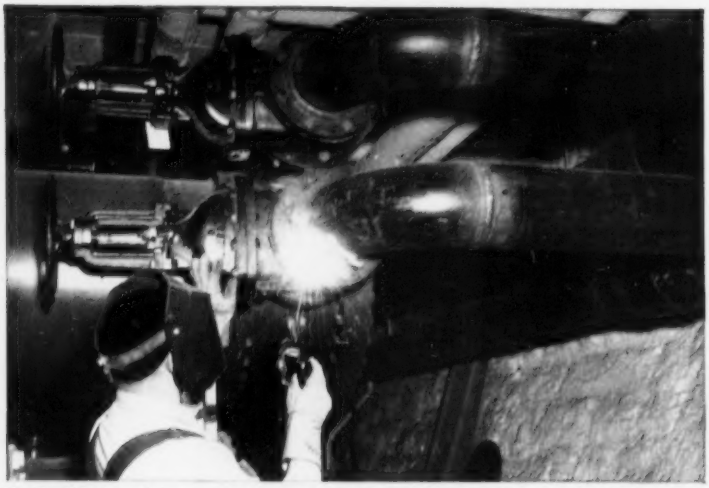
A Division of National Cylinder Gas Company

DISTRICT OFFICES: New York • Philadelphia • Pittsburgh • Cleveland • Detroit • Chicago • Kansas City • Denver
Los Angeles • San Francisco • Seattle • Atlanta • Tulsa • Houston • Dallas • Midland, Texas

APPLICATIONS

TUBE TURNS' *Engineering Service*

helps you apply wrought iron fittings on jobs like these...



Air Conditioning piping . . . wrought iron and TUBE-TURN* Welding Fittings are used for condenser water lines shown here, part of new air conditioning installation at State Capitol Building, Harrisburg, Pennsylvania. Contractors: Riggs Distler & Co., Inc.

Down Spouts on Abbey Avenue Bridge, Cleveland. Made of 10" wrought iron pipe, with 45° TUBE-TURN Wrought Iron Elbows. Contractor: Gorman-Lavelle Co., Cleveland.

Hospital piping . . . wrought iron 5" cold water, 2½" high-pressure condensate returns and 4" pump discharge . . . at City Hospital, Cleveland. TUBE-TURN Wrought Iron Fittings used throughout.

Radiant Heating. Many engineers prefer wrought iron piping for these systems (and snow-removal systems). Shown here: welding in bank of coils to hot water line with TUBE-TURN Welding Tee at Capitol Annex Building, Frankfort, Kentucky. Contractor: B. A. Walterman Co., Cincinnati.

All-around Service. Your nearby Tube Turns' distributor will see that your needs in fittings (of all materials, types and sizes) are met promptly. He will also see that you get Tube Turns' engineering service on your piping applications.

WROUGHT IRON FITTINGS AVAILABLE FROM YOUR NEARBY TUBE TURNS' DISTRIBUTOR

90° ELBOWS | 45° ELBOWS | 180° RETURNS | TEES | CAPS

CONCENTRIC REDUCERS | ECCENTRIC REDUCERS | FLANGES

APPLICATION DATA
for use of TUBE-TURN Wrought Iron Welding Fittings...

TUBE TURNS, Dept. Y-1
224 East Broadway, Louisville 1, Kentucky
Please send Bulletin TT-787 on Wrought Iron Fittings.

Company Name _____
Company Address _____
City _____ *Zone* _____ *State* _____
Your Name _____
Your Position _____

*"TUBE-TURN" and "tt" Reg. U.S. Pat. Off.

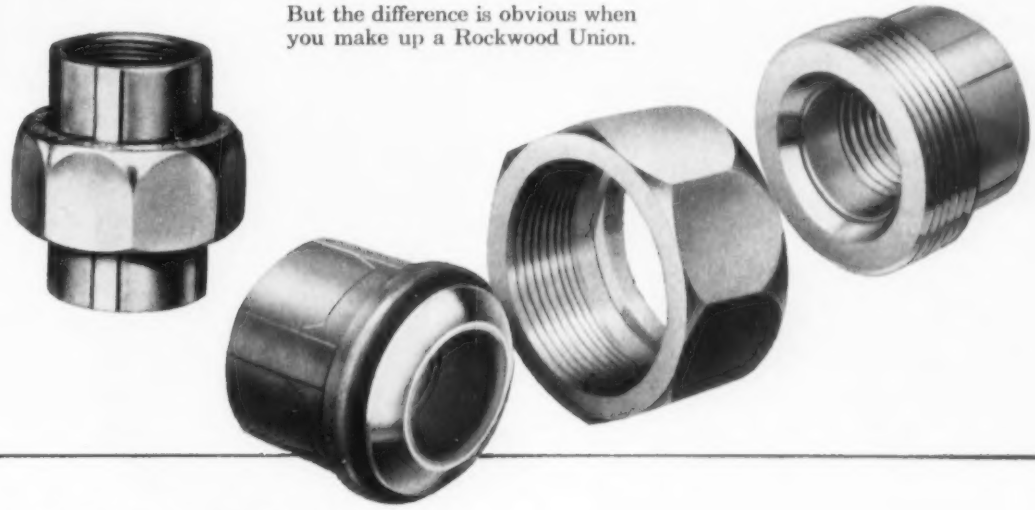
TUBE TURNS

A DIVISION OF NATIONAL CYLINDER GAS COMPANY
LOUISVILLE 1, KENTUCKY

DISTRICT OFFICES: New York • Philadelphia • Pittsburgh
Cleveland • Detroit • Chicago • Denver • Los Angeles
San Francisco • Seattle • Atlanta • Tulsa • Houston
Kansas City • Dallas • Midland, Texas

It's hard to tell the difference between the male and female aardvark.

But the difference is obvious when you make up a Rockwood Union.



Hardness Differential means . . .

No galling in make up!

The male seat of the new Rockwood Union #603 is specially heat treated to make it 150 Brinell harder than the female seat. This hardness differential is the reason there's no galling in make up and longer life for the joint.

Even under difficult working conditions, Rockwood Union #603 gives you superior performance. And each part of the #603 is interchangeable.

There's another big difference that pays off, too! That's exclusive "Rockwoodizing" process that protects the entire Union including threads, against corrosion. Add these big advantages to the fact that both seats are made of corrosion-resistant AISI molychrome steel, forged in place and bonded-locked under 100,000 and 400,000 pound pressure and you'll know why you can't buy a better Union.

Get all the facts, mail coupon now.

ROCKWOOD SPRINKLER COMPANY

Distributors in all principal industrial areas

ROCKWOOD SPRINKLER COMPANY
943 Harlow Street
Worcester 5, Mass.

Please send me prices and further data on the new Rockwood Union #603. I would also like the name of the nearest Rockwood distributor.

Name.....

Title.....

Company.....

City.....Zone..State.....

Fewer Parts Mean Greater Dependability

Floorstand Motor Unit . . . control panel, motor, limit switch and push button station.

Simple, durable mechanism of Chapman's Motor Unit. Handwheel remains stationary during motor operation.

IN CHAPMAN MOTOR UNITS

Chapman's simple and rugged Motor Unit gives accurate, trouble-free control of large valves and sluice gates. It has approximately *half as many parts* as any other unit. Its simplified design, low speed motors and low-ratio, stubtooth gears combine to give positive operation without drift, in *any* position and under all conditions.

Installation is fast and simple. The floorstand unit comes completely wired, ready to connect to leads. Limit switch has micrometer adjustment for exact pre-setting for seating tightness. Motor Units operate smoothly under the most adverse conditions. All units are weather-proof and steam-tight. Write today for *new* Catalog 51.

The Chapman Valve Manufacturing Co.

INDIAN ORCHARD, MASSACHUSETTS

For more data on advertised products, use Readers' Service Cards, last page.

Introducing...

A New Lightweight BS&B Tank Vent And Flame Arrestor *

FEATURES

1 High Capacity

. . . high capacity pressure and vacuum relief comparable to the flow of an open nozzle.

2 Vapor-Tight

. . . one seal only — flexible, positive, replaceable.

3 Rugged with Light-weight Construction

. . . superior design and use of quality materials have resulted in a lighter weight vent.

* PATENT PENDING

The BS&B Type 76-17 Arrestor Vent is a combination vent and cartridge type flame arrestor to prevent the spread of an external flame into the storage tank while venting. The topworks is identical to the Type 76-16 vent (described below), with a modified base to fit the top of the flame arrestor. Clamping edges are interchangeable to allow continued operation of the vent when the arrestor section is removed. Arrestor vents are available in sizes 4" through 12" and mount to ASA bolting circles. Pressure and vacuum settings start at ½ ounce per square inch.

The BS&B Type 76-16 Tank Vent is a lightweight venting device for atmospheric storage tanks containing volatile fluids, and features a floating seal which provides positive shut-off under both pressure and vacuum. This seal consists of two flexible diaphragms which contact valve seats. Easy access is provided to it by a quick-opening V-clamp which holds the cover in place. These vents mount to ASA bolting circles in sizes 4" through 12". Pressure and vacuum settings start at ½ ounce per sq. in.

The BS&B Type 76-18 In-Line Arrestor is for a free vent system, requiring a flame arrestor to protect vent lines on process vessels when the emitted vapors are explosive or ignitible. End flanges are 150 lb. ASA in sizes 4" through 12".

BS&B — EFFICIENCY — OVER 40 YEARS — RELIABILITY — ANOTHER EXAMPLE OF PRODUCT LEADERSHIP

Your BS&B Representative will be glad to give you detailed information. Or you may write to . . .

BLACK, SIVALLS & BRYSON, INC.
Controls Division, Dept. 2-F3
7500 East 12th Street **Kansas City 26, Missouri**

For more data on advertised products, use Readers' Service Cards, last page.

Ross Exchanger protects vital parts in Terry Turbine

Slated for a petroleum refinery, this 600 hp Terry Turbine and Reduction Gear have been designed to drive an induced draft fan.

To protect the gear teeth, journal and thrust bearings, with safe temperature lubrication, a Ross Type BCF Exchanger was installed as an original accessory. *Efficient oil cooling is assured!*

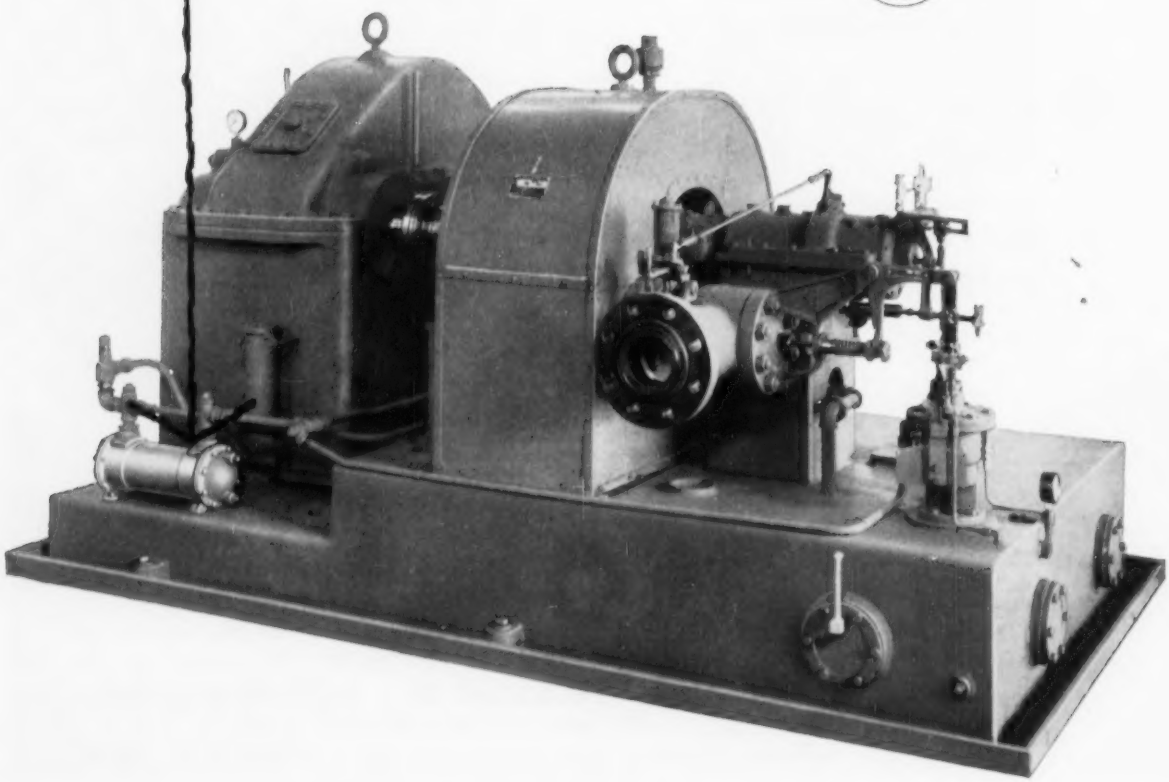
Ross Exchangers are at work in refineries throughout the world. They are not only serving turbines and other prime equipment, but are individually engineered to serve the more specialized distillation units themselves. In fact, wherever there is a cooling, heating or condensing application, they're the No. 1 choice of machinery builders and refiners, who want top thermal efficiency and ruggedness.

Pre-engineered and fully standardized, Ross Exchangers are available in a wide range of designs and sizes to meet *your needs.*

For detailed information, write for Bulletin 1.1K5.

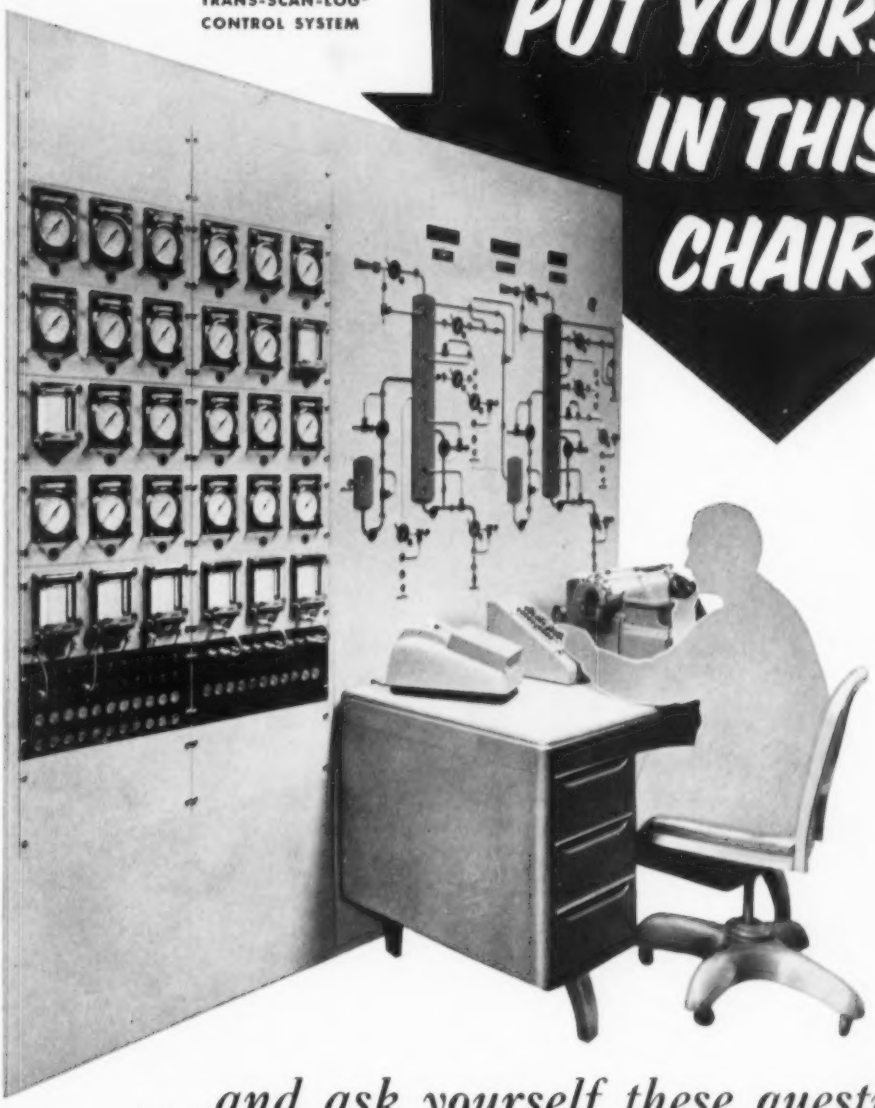
ROSS

ROSS HEAT EXCHANGER DIVISION
of
American-Standard
1419 WEST AVENUE • BUFFALO 13, N. Y.
In Canada: Kewanee-Ross of Canada Limited, Toronto 5, Ont.



TAYLOR
TRANS-SCAN-LOG*
CONTROL SYSTEM

PUT YOURSELF IN THIS CHAIR



. . . and ask yourself these questions

Is scanning and logging, as I understand it, economically justified?

Perhaps not, if you're thinking just of mechanical logging of all variables, which gives little more than an accurate historical record of what has happened. But the new Taylor TRANS-SCAN-LOG System makes the operator more than a score-keeper. It enables him to instantly *visualize, evaluate* and *act upon* every processing irregularity as it occurs — without leaving his desk in front of the panel.

What effect would the TRANS-SCAN-LOG System have on my control room space and operator requirements?

It will take approximately 60% of the space normally required by a standard graphic panel *without* scanning and logging. The compactness of this "intelligence center" enables operator to supervise a greater percentage of the process. Because the scanning and logging equipment is an integral part of the process control, one operator can identify and correct any off-normal condition, as well as having a continuous trend record.

Where can I see this unit in operation?

We cordially invite you to come to Rochester to see this complete data collecting system in operation, because we believe that its many unique features *do* make it economically justified.

Your Taylor Field Engineer will be glad to make the necessary arrangements. In the meantime, write for **Bulletin 98268.** Taylor Instrument Companies, Rochester, N.Y., or Toronto, Canada.

*Trade Mark

Taylor Instruments
MEAN ACCURACY FIRST

For more data on advertised products, use Readers' Service Cards, last page.

The Grinnell Model R Constant-Support Pipe Hanger is available now in an *extended range* of sizes to provide completely overlapping coverage of loads from 47 lbs. to 32,267 lbs., and with travels up to 12 inches. New design modifications permit these hangers to be installed with a minimum of headroom, ranging from 29 inches (rod take-out) for the largest size — down to 10¾ inches for the smallest size.

The Model R provides constant support which is mathematically perfect for all positions of travel. This constancy of support is maintained throughout the full range of field adjustability. Needle bearings minimize friction.

Grinnell Constant-Supports are individually calibrated to support the exact load specified. All Model R Constant-Supports have a full 70 percentage points of field adjustability built into them. No less than 10% of this adjustability is allowed either side of calibration for plus or minus change in load. Field re-adjustments are easily made by turning a single load adjustment bolt.

Grinnell designs, manufactures, and distributes a complete line of pipe hangers and supports for every piping requirement. Grinnell maintains an experienced staff of engineers in the field — ready to assist you on the job with any piping problem.

GRINNELL

AMERICA'S #1 SUPPLIER OF PIPE HANGERS AND SUPPORTS

Grinnell Company, Inc., Providence, Rhode Island • Coast-to-Coast Network of Branch Warehouses and Distributors

pipe and tube fittings • welding fittings • engineered pipe hangers and supports • Thermolier unit heaters • valves
Grinnell-Saunders diaphragm valves • pipe • prefabricated piping • plumbing and heating specialties • water works supplies
industrial supplies • Grinnell automatic sprinkler fire protection systems • Amco air conditioning systems

For more data on advertised products, use Readers' Service Cards, last page.

Sinclair-BAKER RD 150

PLATINUM CATALYST

guaranteed high yields and long life at high octane levels.

REGENERATES IN SITU . . !

The initial efficiency plus regenerative features of Baker's RD150 are unique and of major importance to the petroleum industry. RD150 assures greater yields at high octane levels . . . exceptionally long periods of operation . . . regeneration in situ! RD150 is a joint development of Baker & Co., Inc. and Sinclair Research Laboratories. It is presently being used by such companies as Sinclair, Socony and Pure Oil.

The very extensive facilities for manufacture and refining in modern Baker plants, provide full assurance of prompt deliveries and service.

Upon request, a Baker representative will be glad to give you detailed information.

BAKER & COMPANY, INC. CATALYSTS

113 ASTOR STREET
NEWARK, N. J.

THE HUB OF PLATINUM METALS RESEARCH

How to Set Down Only One Pound of a Nine-Ton Load!

Hydrocrane Does It with Precision Hydraulic Control

1 Hydrocrane's control is so fine that load movement can be almost imperceptible to the eye. Here a 9-ton load is lowered to ordinary household scale on table.

Take a good look at this remarkable demonstration of Hydrocrane control, then picture a Hydrocrane at work for you. For setting beams or concrete slabs, pouring cement or setting a plate glass window — *any* job that requires hairline control — nothing can beat the Hydrocrane in saving you time and money.

The all-hydraulic Hydrocrane is an expert at working in close quarters, too. It has the shortest tail swing, size for size, of any revolving crane, and its unique telescoping boom can reach out and poke a load into hard-to-get-at places.

Contractors who own Hydrocranes call them, "the handiest machine we have." You'll say so too when you get all the facts from your Bucyrus-Erie distributor. Do it soon.

SEEING IS BELIEVING!

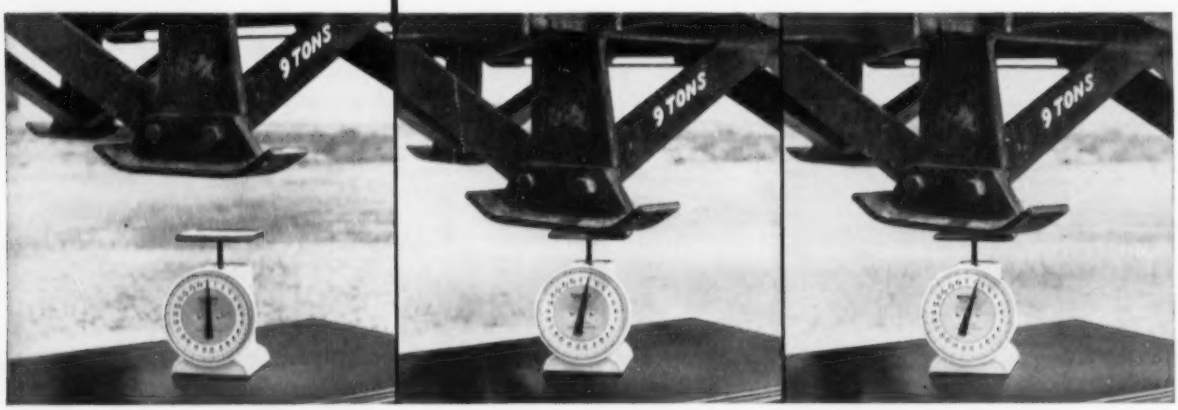
The experiments shown here were made with a standard 9-ton capacity H-5 Hydrocrane at Bucyrus-Erie's test and research grounds near South Milwaukee. The sled and billets, being lifted, totaled 18,363 pounds when weighed on a certified scale. Note that this is *the maximum rated lifting capacity* for this crane — hardly favorable conditions for such a test! 114H56

H-3 HYDROCRANE • 4-ton, ⅜-yard

H-5 HYDROCRANE • 9-ton, ½-yard

BUCYRUS ERIE

South Milwaukee, Wisconsin



2 Closer and closer it comes. No jerks — just a carefully controlled movement as load nears scale.

3 Contact! And so-o-o easy that scale registers only one pound of that big 9-ton load. That's precision control in action!

4 Now the operator "feathers" his control lever a hair, and look—the scale pointer moves to a pound and a quarter!

Years of maintenance-free weatherproofing with jacketing of ALCOA ALUMINUM FOIL cost less than one good paint job

EASY TO CUT AND HANDLE. Four foot wide roll, corrugated for strength, can be cut to length by one man using knife and straightedge.

TWO MEN CAN INSTALL JACKETING EASILY. No special shop work or roll forming needed. Pliers and wedge or screw driver are only tools required.

NO SPECIAL TOOLS NEEDED. Pliers pull aluminum strapping tight. Seals, strapping and jacketing are fully re-usable if line is moved or checked.

OTHER QUICK INSTALLATION METHODS include aluminum sheet metal screws or plastic tape. Aluminum jacketing will not rust, rot or dry out . . . provides lowest cost permanent metal jacketing system.

Now you can weatherproof and protect insulated lines, both outdoors and indoors, quickly, easily and economically—with jacketing of ALCOA Aluminum Foil. Just wrap it and forget it, because metallurgists estimate aluminum jacketing requires *no maintenance for as long as ten years* in many applications.

First costs and application costs are low, too—lower than even the cheapest weatherproofing when the cost of one paint job is considered. In fact, many users find aluminum foil jacketing costs no more—*frequently less* —than one good paint job!

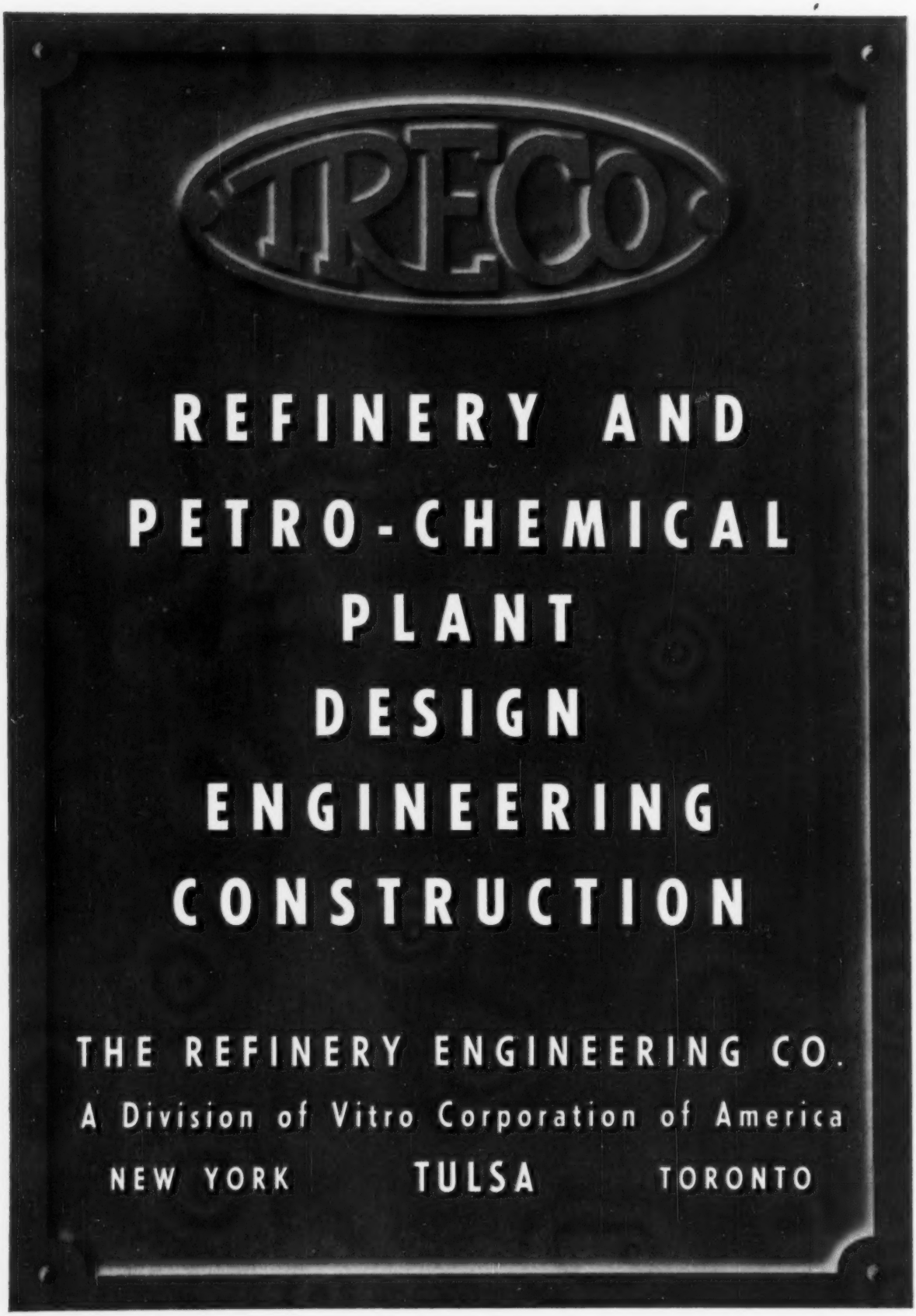
Jacketing of ALCOA Aluminum Foil is corrosion resistant, requires no painting, is available with or without moisture barrier attached. This corrugated aluminum covering can be used over any type of insulation.

ALCOA does not make aluminum foil jacketing, but we will gladly refer you to reputable manufacturers who do. Write to ALUMINUM COMPANY OF AMERICA, INDUSTRIAL FOIL DIVISION, 905-C Alcoa Building, Pittsburgh 19, Pennsylvania.

ALCOA ALUMINUM

ALUMINUM COMPANY OF AMERICA

You're always ahead with Alcoa . . greatest name in aluminum

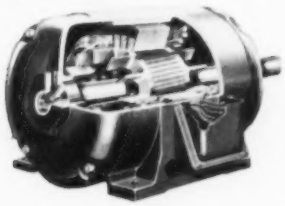


For more data on advertised products, use Readers' Service Cards, last page.

TWO WAYS...with Master Unibrakes

STOP-HOLD—Master Type M Magnetic Unibrake Motors. For quick, controlled stopping—especially when you want to hold the load. Spring-setting magnetic release brakes of the friction disc type combine with motor in a compact, integral unit. Sizes—⅛ to 150 H.P.

ROLLING STOP—Master Type D Dynamic Unibrake Motors. Braking is obtained with a unique, patented brake winding superimposed on the stator winding. Simple, compact, with no DC current required, the brake has no moving parts. There is nothing to wear or adjust—braking torque repeats consistently. Particularly recommended for automatic applications which do not require static holding. Sizes up to 30 H.P.



MASTER GEARMOTORS and variable speed drives can be supplied with integrated Unibrakes too. See Master for the perfect power drive for you.

Type M Unibrake

THE MASTER ELECTRIC COMPANY
DAYTON 1, OHIO

MASTER UNIBRAKE MOTORS

Corrosioneering News

Quick facts about the services and equipment Pfaudler offers to help you reduce corrosion and processing cost.

Published by The Pfaudler Co., Rochester, N.Y.

Temperature: up to 550° F.
Contamination: 0

Contamination from walls of kettle was eliminated by using this 3500-gal. glassed steel vessel.

How this reactor solves 6 problems for Argus Chemical

Making heat and light stabilizers for PVC is a touchy job. You can't risk contamination of your product, and you have to control temperatures within ±1° F., if you want to produce the best quality.

And your operating temperatures range up to 550° F. This combination of conditions posed quite a problem for the men assigned to select equipment at Argus Chemical. They needed a material that was: 1) easy to clean, 2) nonadherent, 3) nonmetallic, 4) capable of accurate heat transfer, 5) corrosion resisting and 6) immune to high temperatures.

Argus solved their problem with the 3500-gallon Pfaudler glassed steel reactor shown here. Using the acid-alkali resisting properties of Pfaudler glass, backed by the structural strength of steel, they added a forced recirculation heating system using Aroclor 1248, Monsanto's fire-resistant heat transfer oil. This gave the fine temperature control they insisted upon. Because practically nothing sticks to glass, they had their freedom from contamination.

You can now obtain these Pfaudler glassed steel reactors in low-cost standard designs, up to 4,000 gallons. Besides the advantages mentioned above, they incorporate many convenience features, such as extra-big manhole, a total of nine top head openings, exclusive Pfaudler agitation, offset bottom outlet and others.

NEW TAKE-IT-APART AGITATOR IS EASIER TO USE AT BOTH ENDS

Increases reactor utility, decreases maintenance cost

Now glassed steel is easier than ever to use! Besides its exceptional corrosion resistance and reasonable cost, it is fast becoming the most flexible equipment on the market.

Latest development is a separable blade agitator, which you assemble *inside* the reaction kettle.

This permits you to switch impellers in a jiffy, without disturbing the drive or seal. And it enables us to use a smaller agitator opening, providing more working space at the top head for additional openings, if desired.

Needs only 2 tools

All you need to assemble the impeller are a socket wrench and a strap wrench. Assemble the two sections of the blades, anchoring them with the bolt provided. Then cap the assembly with glassed hex nut. Glass and Teflon are the only materials exposed to your product.

Besides lowering maintenance and changeover time, this agitator cuts stock costs, because you don't have to store the whole fixed agitator-impeller assembly. Just stock an extra impeller, at much lower cost.

Stuffing box or seal

At the top end, another new development increases the versatility of this agitator. It's designed to work with either stuffing box or rotary seal, permitting changeover in a matter of minutes. This is important when your process changes and a different type of seal is needed quickly.

At present, these agitators are being placed into production, and will be available at a later date, soon to be announced.

IMPELLER has separable blades held together by glassed hex nut.

*Patents pending

Getting it there is half the headache

Transfer of corrosive products can give you nightmares.

Piping, valves, fittings must be corrosion resistant—and rugged as well.

In our new Bulletin No. 886, you'll find a complete description of Pfaudler heavy duty glass lined pipe, valves and fittings to ease your worries. Write for your copy.

Reprints available:

Study reveals influence of carbon in glassed steel

The role of carbon in the enamelling of steel is important to you, if you process corrosive chemicals, since glassed steel is often the only equipment suited for such service.

After a thorough probe into the subject, three authorities have pooled their knowledge and incorporated their findings in a paper which appeared in the Journal of the American Ceramic Society.

Its title: "Some Influences of Carbon in Enamelling of Steel." The authors: Gordon P. K. Chu (of Pfaudler research), J. K. Magor (R.P.I.) and H. M. Davis (Penn State). Reprints available on request.

For more data on advertised products, use Readers' Service Cards, last page.

1350

Since 1940

A record of installations

that in itself is incomparable

just as all Petro Chem Isoflow Furnaces

are most efficient by any comparison

PETROCHEM-ISOFLOW FURNACES

UNLIMITED IN SIZE . . . CAPACITY . . . DUTY

PETRO-CHEM DEVELOPMENT CO., INC. • 122 EAST 42nd St., New York 17, N. Y.

REPRESENTATIVES:

Rawson & Co., *Houston* • Wm. H. Mason Co., *Tulsa* • Lester Oberholtz, *Los Angeles* • Faville-Levally, *Chicago* • D. D. Foster, *Pittsburgh* • Turbex, *Philadelphia* • Flagg, Brackett & Durgin, *Boston* • G. M. Wallace, *Denver*

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For more data on advertised products, use Readers' Service Cards, last page.

to meet exacting lubrication standards, specify

ENJAY PARATONE®

viscosity-index improver

Refiners and blenders rely on Enjay Paratone for compounding oils that combine cold-weather, quick-starting properties with low consumption characteristics.

You can also count on Enjay for a prompt solution to your additive problems. The Enjay Company, pioneer in petroleum additives, has extensive experience in working with oil companies and leading engine manufacturers to develop additive formulations. Whatever your use of additives, you can benefit from this experience.

For complete information, write or call the Enjay Company—your only source of a *complete* line of additives (Paramins®) for fuels and lubricants.

ENJAY

Pioneer in Petrochemicals

ENJAY COMPANY, INC., 15 WEST 51st STREET, NEW YORK 19, N. Y. • Other offices: Akron, Boston, Chicago, Tulsa

At last...the solution to

really tough

gas-cleaning problems

Sub-micron fumes are the **really tough** gas cleaning problems. These fumes cannot be economically or effectively controlled by conventional cleaning devices.

However, the Chemico P-A Venturi Scrubber is proving its success in solving these **really tough** problems in more than 150 commercial installations and in more than 70 pilot investigations.

The table lists some of these commercial installations. All of these **really tough** problems and many more are being solved with complete satisfaction to users of P-A Venturi Scrubbers.

PROCESS	DUST OR FUME	INSTALLED CAPACITY CFM
Incinerator—Flue Fed	Fly Ash	32,000
Incinerator—Sodium Disposal	Na_2O	9,000
Incinerator—Industrial	Radioactive Dust	6,000
Dry Ice & CO_2 Plants	Amine Recovery	72,400
CO_2 Gas for Process	Fly Ash	500
Boiler Flue Gas	Fly Ash & SO_2	4,300
Enamel Frit Furnace	Dust & HF	11,900
H_2SO_4 Concentrator	H_2SO_4	49,800
Copperas Roasting	H_2SO_4	34,250
Cobalt Ore Roasting	H_2SO_4	65,000
Chemico Wet Type Acid Plant	H_2SO_4	41,000
Chloro-Sulfonic Plant	H_2SO_4	600
Phosphoric Acid Plant	H_3PO_4	91,900
Phosphoric Acid Concentrator	H_3PO_4	194,000
Phosphor Copper Furnace	H_3PO_4	15,000
Smelting—Non-Ferrous		
Blast Furnace	Lead & Organic	12,000
Reverb. Furnace	Lead Compounds	23,500
Comb. Blast & Reverb.	Lead Compounds	7,000
Brass Furnace	Zinc Oxide	7,500
Ajax Furnace	Beryllium Fumes	4,000
Steel Plant		
Oxygen Steel Process	Iron Oxide	140,000
Blast Furnace	Coke & Iron Oxides	788,000
Zinc Sintering	Zinc Oxide	75,000
Wood Distillation	Tar Products	3,500
Na_2SiF_6 Dryer	SiF_4 & Dusts	700
Iron Chloride Concentrator	$FeCl_2$ & HCL Mist	40,000
Unknown	Carbon Black	1,700
Lime Kiln	Lime & Na_2O	18,000
Detergent Spray Dryer	Chemical Fume	250,000
Furfural Residue Burner	Fly Ash	36,000
Nodulizing Kiln	Manganese & Lead	25,000
Aluminum Pot Lines	Tar Fog, Fluorides	40,000
Carbide Furnace	Metal Oxides	1,000
Asphalt Plant	Rock Dust	80,000

Write to our P-A Sales Department for Bulletin M-102 describing the simple operating principle of the P-A Venturi Scrubber, and Bulletin M-103 explaining its metallurgical fume applications in the steel industry.

CHEMICO

P-A

(PEASE-ANTHONY)

VENTURI SCRUBBERS

CHEMICAL CONSTRUCTION CORPORATION

A UNIT OF AMERICAN CYANAMID COMPANY

525 WEST 43rd STREET, NEW YORK 36, N. Y.

Technical Representatives Throughout the World

Telephone LOngacre 4-9400

Cable Address: CHEMICONST, N. Y.

CC 907

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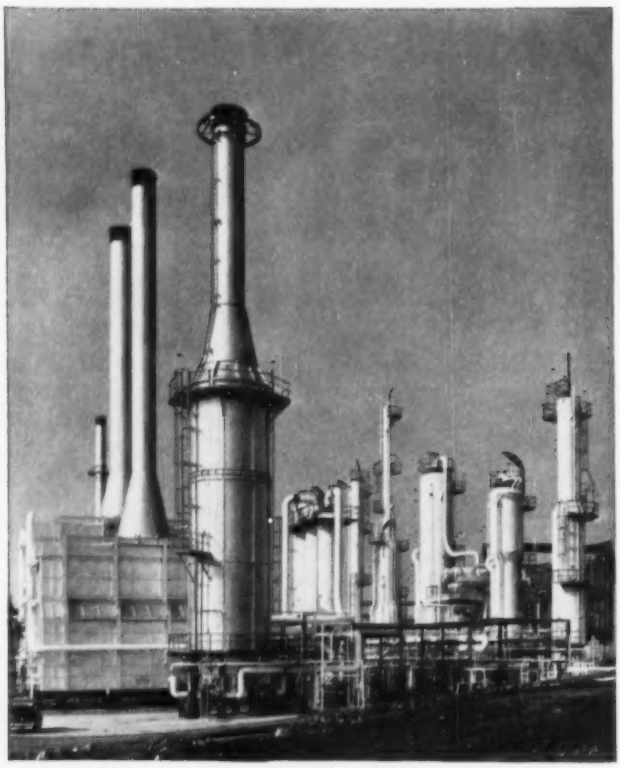
INTERESTED IN UNIFINING* FOR DESULFURIZATION AND UPGRADING



• Unifining Unit
Union Oil Company of California refinery
Oleum, California

UNIFINING should be of particular interest to all operators of catalytic reformers which produce by-product hydrogen.

• Harshaw is the exclusive producer of the Union Oil Company of California cobalt-molybdate catalyst used in the recently announced "Unifining" desulfurization and upgrading process. This rugged, commercially proven catalyst is supplied in the form of cylindrical tablets conforming to rigid physical and chemical specifications established by Harshaw and Union Oil Company of California. Stability at high temperatures permits repeated regenerations if and when necessary.

Please contact Harshaw for further information on this catalyst.

HARSHAW

THE HARSHAW CHEMICAL CO.

1945 East 97th Street, Cleveland 6, Ohio

Chicago 32, Illinois • Cincinnati 13, Ohio • Detroit 28, Michigan • Hastings-On-Hudson 6, N. Y.
Houston 11, Texas • Los Angeles 22, California • Philadelphia 48, Pennsylvania
Pittsburgh 22, Pennsylvania

* Trademark of Union Oil Company of California

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DU PONT REG. U.S. PAT. OFF.

PETROLEUM CHEMICALS DIVISION

NEWS

DU PONT REG. U.S. PAT. OFF.

March ★ One of a Series of Interest to the Petroleum Industry ★ 1956

Question Box

1. ARE YOU having trouble keeping costs down as octane ratings go up?
   The new Du Pont service described at right can help you with this problem.
2. DO FOULED heat exchangers plague you with costly downtime and spoiled product?
   Du Pont FOA-2 may help solve this problem.
3. IS THERE A DANGER of additive extraction when fuel oils pass through dehydrators?
   The next page has an article on this subject.
4. WHO can help you get the highest octane at the lowest refining cost?
   See next page.

FOA-2 reduces heat exchanger fouling—helps keep process unit on stream longer

Fouled heat exchangers cost time and money and premature process unit shutdowns.

Du Pont Fuel Oil Additive No. 2 (FOA-2) promises relief from this frequent and troublesome problem.

A little does a lot

Fouling due to unstable stocks such as coker distillates can be minimized by adding FOA-2 in concentrations of as little as 20 to 30 lbs. per 1,000 barrels. It should be added at the beginning of the processing run.

In cases where the heat exchanger fouling is severe enough to cause shutdowns as often as every few days, this treatment will generally extend, to as much as a month or two, the period between shutdowns. And during this extended operating time, FOA-2, as a result, will help to reduce the loss in heat transfer coefficient.

Useful in pipelines, too

Another effective application for FOA-2 is for cleaning pipelines. In concentrations of 50 lbs./1,000 barrels, in No. 2 distillate, it does an excellent job of keeping the contamination in suspension and removing it in advance of the new product.

Why not try it? Its rapid, thorough cleaning will mean lines that are free of contamination and ready for clean product service immediately.

Other uses

Du Pont Fuel Oil Additive No. 2 was originally developed as a stabilizer and dispersant for home heating oils. As such, it does a highly efficient job of preventing and dispersing sludge formations that cause screen and filter clogging.

In addition – being a nonmetallic *ashless* additive – it does not leave a metallic ash deposit which can foul the operation of the electrical system. Thus, it helps to prevent ignition failures that cause customer dissatisfaction and wasteful service calls.

In diesel fuels, the excellent dispersant action of FOA-2 improves filterability. In this way, it helps to eliminate most injector-sticking and filter-plugging problems.

THIS DU PONT TECHNICAL SERVICE MEANS . . .

More octane numbers per dollar

Octane requirements are increasing so fast that many refiners are facing the choice of either a squeeze on their profits or an advance in their gasoline price. This predicament is brought about by the pyramiding costs of each octane number increase in the 90 to 100 range. In this connection, there are times when a refinery technologist experienced in this specialized field may be of considerable help in the control of costs.

Jack S. Bellah, a Du Pont refinery technologist, is shown here discussing a more economical method of obtaining octane numbers.

The Du Pont Petroleum Chemicals Division is glad to offer you the services of such specialists. The value of their services has been proven in a number of refineries during the past year.

Based on market requirements

Unfortunately, most refiners are forced to do a certain amount of uneconomical processing in order to balance their particular market requirements. But this does not mean that substantial savings in processing cannot be realized – by carefully analyzing and adjusting *all* the factors influencing octane costs.

These factors include the particular gasoline blend, the octane level under consideration, and

OVER

ADVERTISEMENT—Prepared for the Petroleum Chemicals Division of E. I. du Pont de Nemours & Company (Inc.)

PETROLEUM CHEMICALS DIVISION
NEWS

CONTINUED *Octane Economy*

the method of achieving this desired level. These factors, and their relation to each other, will vary with each individual refining operation. Also affecting the octane cost are the spread in value between intermediate fuels immediately adjacent to the gasoline fraction, and the flexibility of the market between these fuels and gasolines.

Tailored to your operations

For these reasons, the Du Pont *octane economy service* also takes into consideration all the market factors which influence your refining operations. Then a thorough study of the actual processing operations is made to determine the most economical course for reaching your desired octane requirements.

How it's done

Assuming that catalytic reforming is today the principal processing variable in gasoline quality control, then the method of operating the reformer determines to a large extent the cost of achieving a desired octane level.

For maximum economy

At all octane levels, the most economical cost results when the optimum combination of catalytic reforming operations and tetraethyl lead dosages is used. In some instances the maximum usage of TEL, 3.0 cc per gallon might be more economical than increasing the severity of the reforming operation. But this is by no means always true. Generally a combination of moderately severe reforming conditions, commensurate with the octane requirements of the existing market situation, and intermediate TEL dosages result in the lowest possible costs.

Valuable aid

By determining the most economical processing steps and reforming severity, in relation to your own individual stocks and market requirements, the Du Pont *octane economy service* can provide a most valuable aid to your own process engineering.

If you would like more information about this service and how it can help you maintain your profit margins, just drop us a line.

HEADS DU PONT OCTANE ECONOMY SERVICE

Jack S. Bellah joined the Petroleum Chemicals Division as Refinery Technologist in 1953. A graduate of the University of Tennessee with a B.S. degree in chemical engineering, he completed a year of study under a T.V.A. chemical engineering scholarship.

For six years, he was employed by the Socony-Vacuum Oil Company. His activities ranged from routine control testing through heavy oils blending, conservation engineering, operations control and equipment testing, unit yields and economic studies, process engineering and product development.

He then joined Mathieson Alkali where he was engaged in chemical engineering development work.

In 1946, he became a process-project engineer at Stanolind Oil and Gas Company in Tulsa. After working on two of the large joint venture gasoline plant projects in West Texas, he joined the Refinery Engineering Company in Tulsa in 1950. There he coordinated all the company's process activities and economic studies.

Do dehydrators remove Du Pont FOA-2 from distillate fuels?

Laboratory and field tests prove the absorption rate is *less than 1%*. And the negligible amount absorbed does not interfere with the water removal efficiency of the bauxite dehydrators.

For example

In a field test, 74,000 barrels of a No. 2 distillate fuel oil were treated with 18.8 pounds of Du Pont Fuel Oil Additive No. 2 per 1,000 barrels. This stabilizer and dispersant was injected into the circulating line of the storage tank while the fuel was being recirculated. The storage tank contained 8 inches of water. Since the fuel was destined for shipment through a pipeline, a dry fuel was desired.

The treated fuel was pumped from the storage tank through two 100-barrel capacity bauxite dryers operating in parallel, then into the pipeline. Each dryer contained sixteen tons of bauxite.

The test fuel was sampled before and after the dryers . . . and at regular intervals throughout the 31-hour shipment.

Results

The fuel was bright and dry when it left the dehydrators. The FOA-2 content of fuel entering and leaving the dryers was equal. It remained uniform throughout shipment.

When the fuel was checked in at destination, no loss in stability was noted and in this respect the fuel proved to be superior to the base fuel without additive.

DU PONT
REG. U.S. PAT. OFF.

Better Things for Better Living
. . . *through Chemistry*

Petroleum Chemicals

E. I. DU PONT DE NEMOURS & COMPANY (INC.) *Petroleum Chemicals Division* • *Wilmington 98, Delaware*

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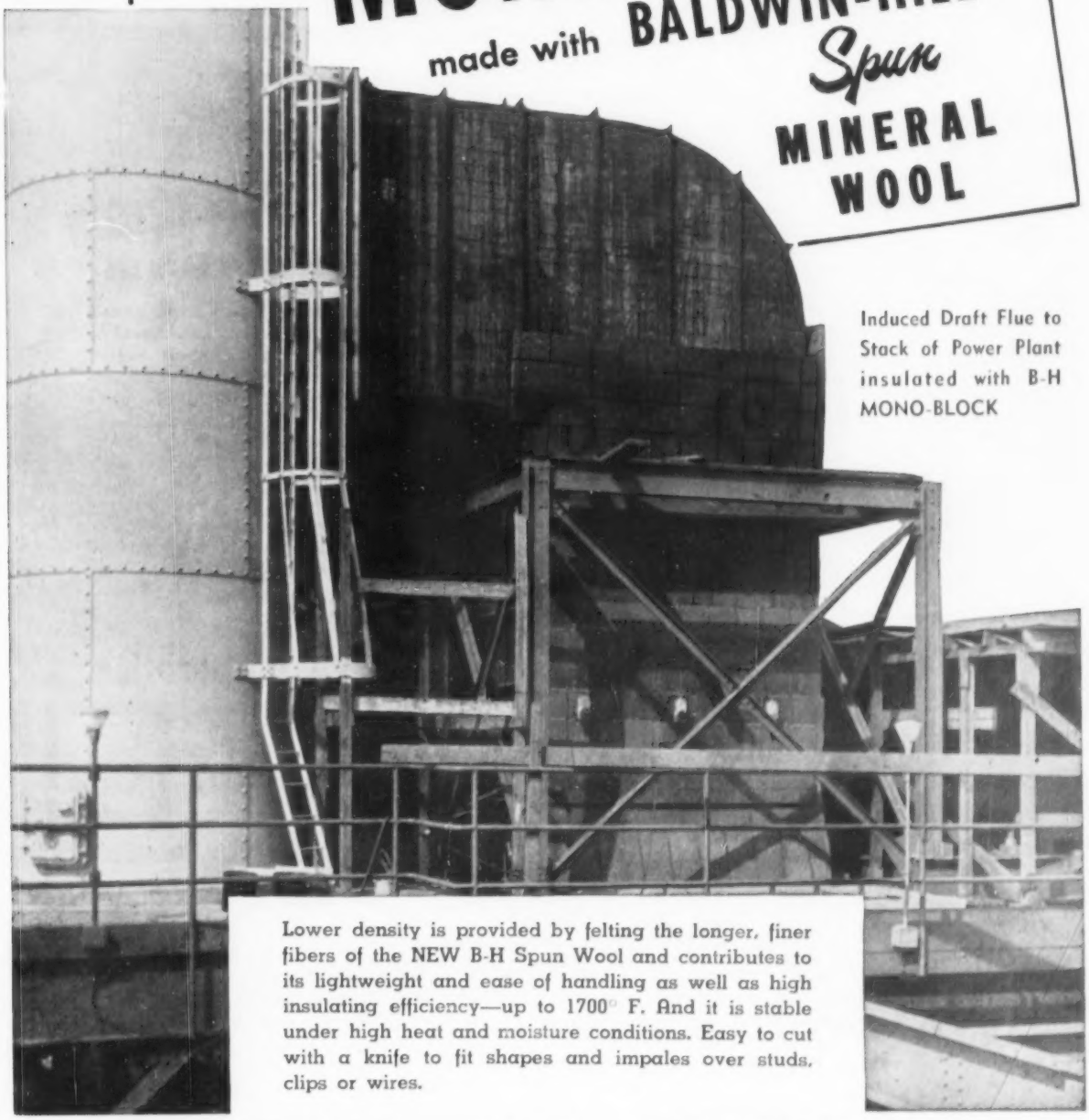
A-989

Printed in U. S. A.

BALDWIN-HILL INSULATIONS

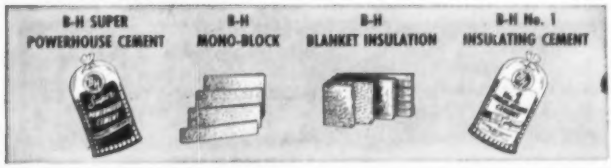
NEW LIGHTWEIGHT MONO-BLOCK

made with BALDWIN-HILL *Spun* MINERAL WOOL



Induced Draft Flue to Stack of Power Plant insulated with B-H MONO-BLOCK

Lower density is provided by felting the longer, finer fibers of the NEW B-H Spun Wool and contributes to its lightweight and ease of handling as well as high insulating efficiency—up to 1700° F. And it is stable under high heat and moisture conditions. Easy to cut with a knife to fit shapes and impales over studs, clips or wires.



BALDWIN-HILL COMPANY

1603 Breunig Ave., Trenton 2, N. J.

Kalamazoo, Mich. . . Huntington, Ind. . . Temple, Texas

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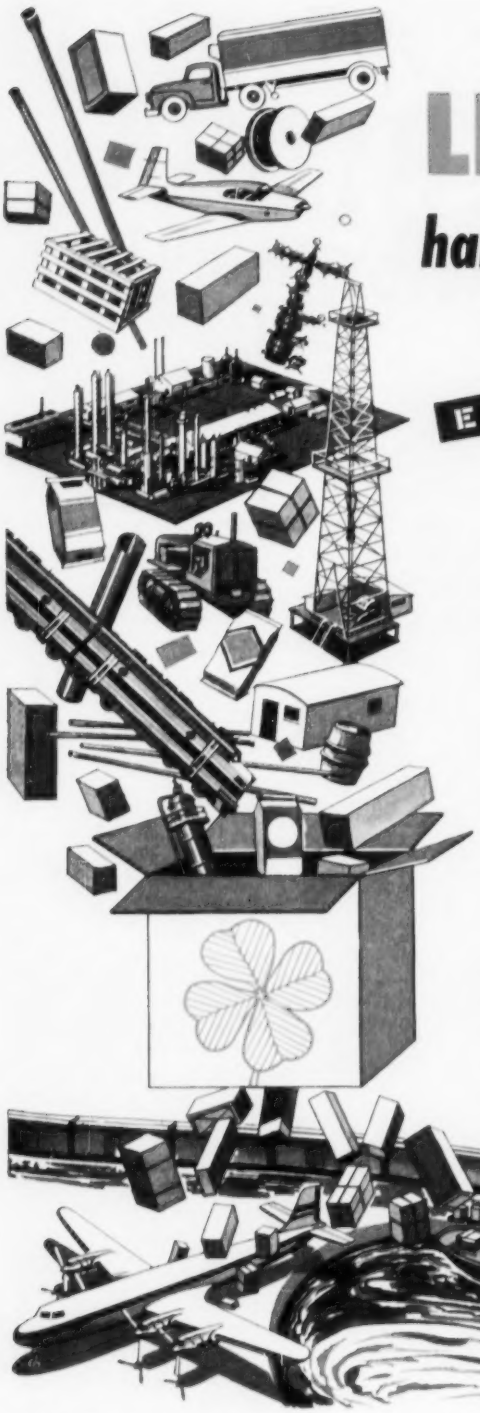

LEE'S expert export service handles the Complete Package!

EXPORT CRATING
FORWARDING
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ADVANTAGES OF DOING BUSINESS WITH LEE

You get the complete job done by Lee's experienced personnel, using Lee's modern facilities. Lee receives, checks and consolidates all material. Lee's expert, export crating earns you lowered insurance rates, prevents customs fines, and saves you money by consolidation. Lee's complete service also includes bonded warehousing, accurate packing lists, transport to loading dock, arrangements for loading and unloading and ship charter. In short, if you are shipping anything, from a rhinoceros to a complete refinery, Lee's experienced personnel will deliver the material on foreign docks freeing you of all worry—on schedule, safely and economically.

The people at Lee know. Write, wire, or call today and let a Lee man give you the complete story.

LEE Construction Corporation

WA 3-5553 P. O. Box 253 Houston 1, Texas

Affiliated Companies
Lee Corporation—Lee Shipping Company—
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The Fluor Corporation, Ltd.
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J. B. Beaird Co.

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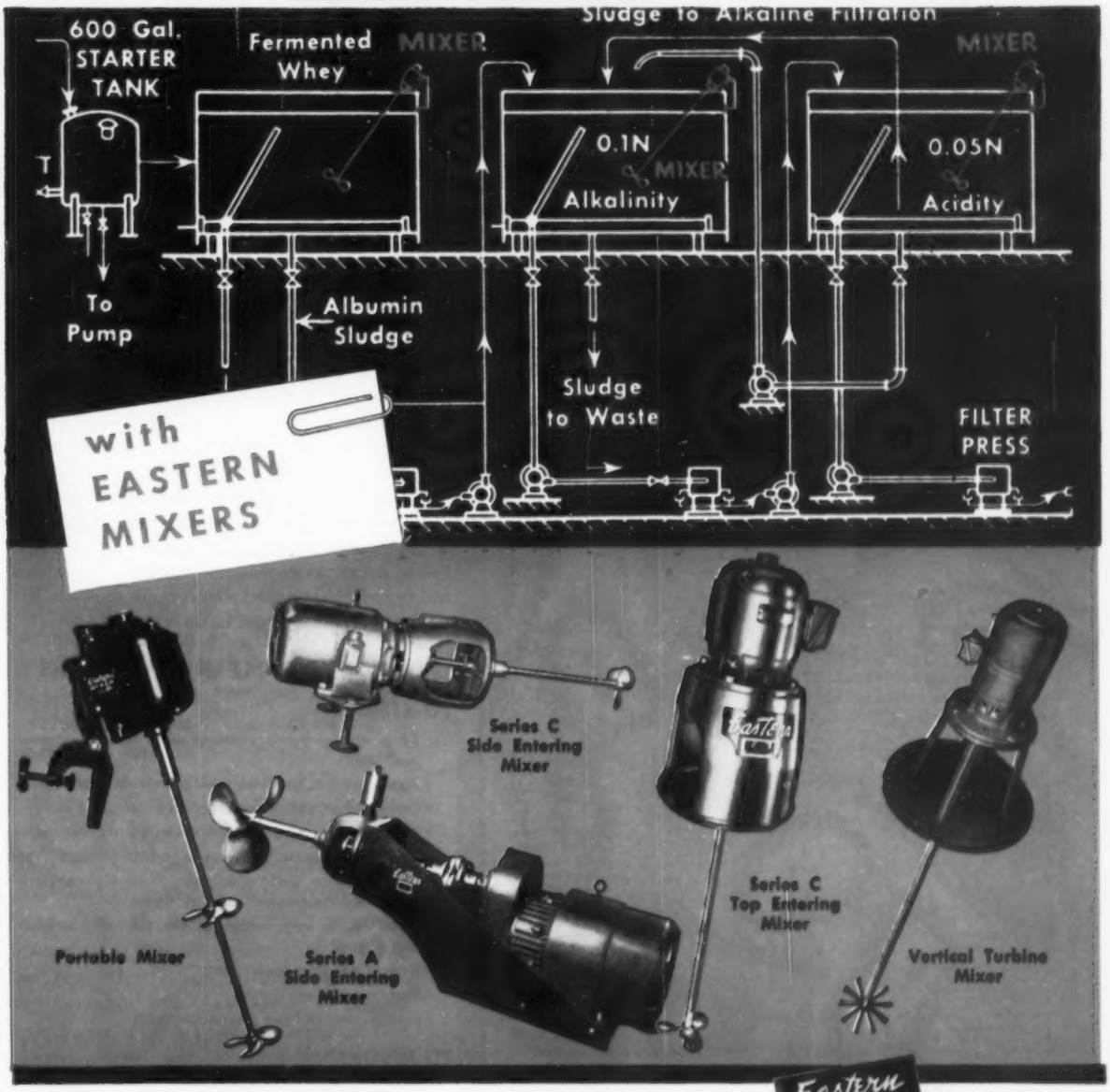
RELIABLE FLUID MIXING in PROCESSING



Eastern's Mixers are designed to meet the needs of today's chemical and industrial processes. Many types are available to satisfy all conditions of fluid consistencies and tank sizes. Selection may be made from a wide range of horsepower, speed, and construction materials. Motors with various voltage ratings and enclosures are also furnished.

PORTABLE MIXERS

Series H at 1725 R.P.M., Series S at 1125 R.P.M., and Series G at 420 R.P.M. are available in motor ratings from 1/20 to 5 H.P. Also available are special speeds, variable speeds, as well as air driven models.

TOP AND SIDE ENTERING

Series A, extra heavy duty for large tanks, are available in side entering units only within a range of 5-30 H.P. with standard speeds of 280, 420, and 1150 R.P.M.

Series C, for average tank capacities, are available in sizes of ¼ to 10 H.P. at these standard speeds: 1725 R.P.M. (up to 5 H.P.); 1140 R.P.M. (up to 10 H.P.); 420 R.P.M. (up to 7½ H.P.); 280 R.P.M. (up to 5 H.P.). Available in both horizontal and vertical models.

TURBINE MIXERS

Eastern's Top and Bottom Entering Turbine Mixers find particular application where liquid blending requires gentle, yet thorough agitation.

Models are available in sizes from ¼ to 40 H.P. Standard speeds are 56, 68, 84, 100, 125, 155 R.P.M.

For 3 bulletins covering Eastern Mixers, request Catalog Series 28.

Eastern INDUSTRIES, INC.
Mixer Division
Regent St.,
Norwalk, Conn.

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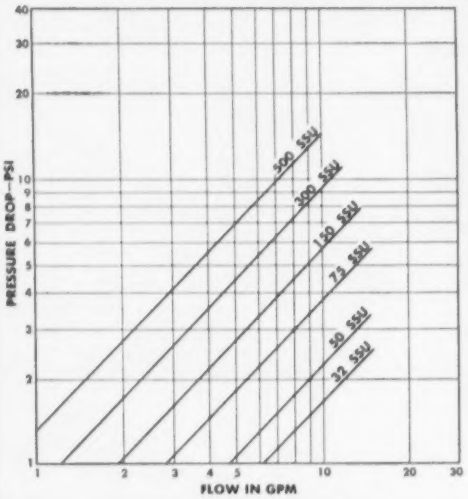
DESIGN AND APPLICATION NOTES ON

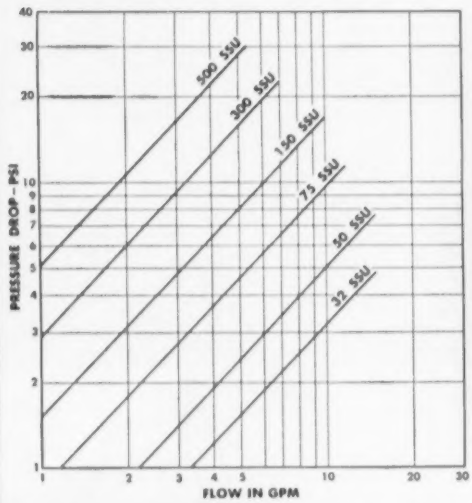
Cuno's new Poro-Klean Filter

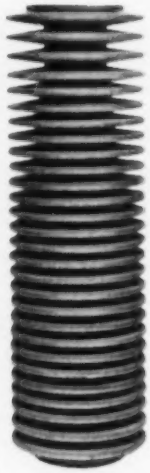
TYPICAL PORO-KLEAN FLOW DATA



CYLINDRICAL TYPE

FLOW DATA FOR TYPICAL CYLINDRICAL-TYPE, coarse-grade, PORO-KLEAN filter element, fluid viscosity as parameter. Filtration to 15 microns.





CELL TYPE

FLOW DATA FOR TYPICAL CELL-TYPE, medium-grade, PORO-KLEAN filter element, fluid viscosity as parameter. Filtration to 5 microns.

Precision 3-to-30 micron filter for high temperature and high pressure

PORO-KLEAN, Cuno's new porous stainless steel filter material, now offers the chemical, petrochemical, nuclear, and process industries true micronic filtration for temperatures to 900°F and differential pressures to 2000 psi.

Standard in 316 stainless steel, with low carbon content (0.03 to 0.05% max.), PORO-KLEAN is an ideal filter material for use in applications requiring corrosion resistance, high strength (ultimate tensile strength: 25,000 psi), high resistance to hydraulic shock, or positive freedom from fluid contamination.

Typical PORO-KLEAN applications, already in use in the chemical and process industries, are listed below. Approximate flow-rate curves for typical cell and cylindrical standard elements are shown at left (for exact data, see your Cuno representative).

TYPICAL PORO-KLEAN APPLICATIONS

TO REMOVE:

- Resin and airborne contamination from demineralized water
- Fixed-bed catalyst fines from petroleum products
- Over-cooked gels from polymers
- Radioactive contamination from light and heavy water
- Fine precoat particles downstream from primary filters
- Contamination and/or catalysts from high-temperature and high-pressure refinery gases
- Metal oxides from molten sodium, sodium-potassium, and bismuth
- Iron oxides from fuels
- Rust from steam
- Foreign matter from pharmaceuticals

TO RECOVER:

- Catalysts from gases and liquids

TO DISPERSE:

- Gases into liquids and other gases

If you have problems like these, let Cuno engineers help you apply PORO-KLEAN to their solution. See your Cuno representative, or write Cuno Engineering Corporation, 33-3 South Vine Street, Meriden, Conn. 5.20

CUNO

ENGINEERED FILTRATION

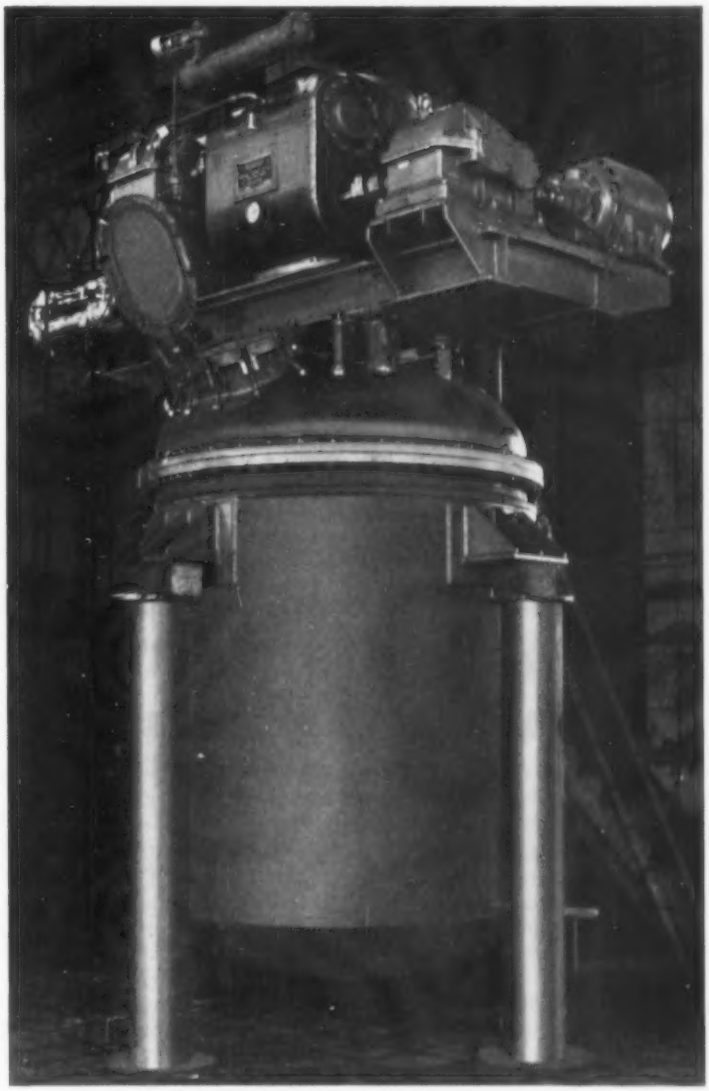
Removes More Sizes of Solids From More Kinds of Fluids

AUTO-KLEAN (edge type) • MICRO-KLEAN (fibre cartridge) • FLO-KLEAN (wire-wound) • PORO-KLEAN (porous stainless steel)

Buflovak Jacketed Grease Kettles are engineered for specific process requirements

...to fit specific processing operation needs

...to provide profitable performance



The kettle illustrated is a Buflovak Jacketed Grease Kettle with a 2500-gal. capacity. It is equipped with a compact 150-hp Cone Gear Drive for operating a Double Motion Agitator, with scrapers, to speed operation. A pneumatic discharge valve saves valuable time. It was designed and engineered by Blaw-Knox engineers to meet the specific requirements of the operation for which it was built.

We can help you solve your kettle problems. Blaw-Knox engineers have had a broad experience in designing and building kettles of every description, from the laboratory—few-gallon, capacity models to ones that process several thousand gallons—not just greases but a large number of varied products. This experience enables our engineers to incorporate in the design of each kettle all the features that are particularly applicable to the operation under consideration. Such features include size of kettle, type of body, agitators, drive, high or low temperature control, method of heating and cooling, heat source, openings and outlets, and so on.

Why not call us and let Blaw-Knox engineers make their recommendations?

A Complete Process Equipment Service

Kettles of every description constitute but one phase of Blaw-Knox Process Equipment design, engineering and fabrication service for the chemical, food, pharmaceutical, plastic and resin, petroleum, rubber and other industries: EVAPORATION • DRYING • FLAKING • MIXING • REACTION IMPREGNATING • VULCANIZING • SOLVENT RECOVERY SOLVENT EXTRACTION • CRYSTALLIZATION • DISTILLATION POLYMERIZATION • GAS CLEANING • GAS ABSORPTION • HEAT TRANSFER • VAPORIZATION • CONDENSATION • STERILIZING LOW AND HIGH PRESSURE PROCESSING

CATALOG NO. 356-R is available on request

BLAW-KNOX

Everything in Process Equipment

BLAW-KNOX COMPANY

BUFLOVAK EQUIPMENT DIVISION

1601 Fillmore Avenue, Buffalo 11, N. Y.

For more data on advertised products, use Readers' Service Cards, last page

BRIDGEPORT BRASS COMPANY
CONDENSER AND HEAT EXCHANGER TUBE EDITION

COPPER ALLOY BULLETIN

Bridgeport Brass Co. MILLS IN BRIDGEPORT, CONN. AND INDIANAPOLIS, IND.—IN CANADA: NORANDA COPPER AND BRASS LIMITED, MONTREAL

New Electronic Spectrograph Maintains High Tube Quality

One of the important aspects of the manufacture of heat exchanger tubes is the maintenance of uniformly high metallurgical standards.

Metallurgical quality control has been of prime importance to Bridgeport Brass for many years, since it is essential to top product performance as well as customer satisfaction.

Whenever possible, Bridgeport has utilized the latest advances in product quality control, developed new techniques for analysis, and adopted new instruments to aid metallurgists in maintaining uniform quality. A typical example of this is the use of a newly developed electronic spectrograph to analyze the composition of alloys from which Bridgeport makes heat exchanger and condenser tubes.

In operating this spectrograph, a small cast sample of the alloys is positioned in the instrument. By means of an electric arc the sample is instantaneously heated to a vapor state. This vaporized portion emits a brilliant light which, by means of a grating, is broken up into the component wave lengths of the various elements present in the specimen in much the same way daylight is divided into a multihued spectrum by a prism. These wave lengths are directed on a battery of sensitive photoelectric cells, and the voltage developed by the cells as a result of the light striking them is measured and used as the controlling medium. A ratio of the intensities of the wave lengths is automatically recorded on a chart and calibrated to permit a direct reading of the percentage of each element in the sample.

With Bridgeport's Spectrometer it is possible to make a complete analysis of a sample containing as many as 14 elements in less than five minutes. Formerly, an analysis could take as long as 16 hours to complete.

Bridgeport was one of the first companies to use this instrument for copper-base alloy analysis. Both company metallurgists and production experts derive important benefits from electronic analysis as compared with the standard spectrographic and chemical methods.

At Bridgeport's plants, billet samples taken from casting furnaces are sent via pneumatic tubes to the electronic spectrograph. Because an analysis is completed in a matter of minutes, changes in the mixture in many instances can be made before the next sample is taken.

Bridgeport's condenser tube customers are benefiting directly by this improved spectrograph service. The electronic spectrograph has helped to combat corrosion by accurately determining the exact alloy composition for any given tube service in addition to lowering production costs, reducing waste, and stepping up movement of metal from furnaces to rolling mills. By reducing the load on photographic-type spectrographs for analysis, production of top-quality metal is accelerated, permitting improvement of Bridgeport's policy of giving immediate consideration to customer's specifications and analysis requests.

Drum comparator (above, left) quickly indicates compositions determined by spectrograph.

In addition to achieving more control by use of the spectrograph, the mechanics of alloy analysis have been greatly speeded. As a result, Bridgeport metallurgists are able to devote more time to research and experiments with new alloys for heat exchanger and condenser tubes.

Use of the electronic spectrometer marks a tremendous advance in product testing and control. Addition of this instrument to its facilities is just one of the many forward-looking steps constantly being made by Bridgeport Brass to bring better condenser and heat exchanger tubes and service to its customers. (4389)

For more data on advertised products, use Readers' Service Cards, last page.

BETZ• *A Great Name*
In Water Conditioning

"Prescriptions" by the truckload!

Solving industrial water conditioning problems effectively and *economically* requires exacting engineering techniques.

There are no stock answers . . . no stock chemical treatments.

We realize this perhaps more than anyone. In fact, we make a business of it.

For example, each year at our mixing and formulating plants in Pennsylvania, Texas, California, and Quebec, we blend and ship thousands upon thousands of different "prescriptions", each specifically job-engineered to solve some individual water conditioning problem for industry. Because we feel it is so important to "tailor-make" our formulations, each of our plants actually performs the function of a giant industrial pharmacy.

The blending and shipment of our chemical formulations is, however, only one important part of our *completely-individualized* water conditioning service. Individual investigations, plant control methods, daily testing programs, periodic checkups, analyses of water samples, and regular engineering reports all combine to provide a water conditioning service that is complete in every detail.

The end result of individual attention to individual problems is obvious . . . the assurance of a plant (perhaps your own) operating at peak efficiency, free from water problems.

A 20-minute, no obligation discussion of your plant water problems with a Betz District Engineer is the best investment in time you can make. Call him in today.

W. H. & L. D. BETZ, Gillingham & Worth Streets, Philadelphia 24, Pa. In Canada: BETZ Laboratories Limited, Montreal 1.

BETZ

CONSULTANTS ON INDUSTRIAL WATER PROBLEMS

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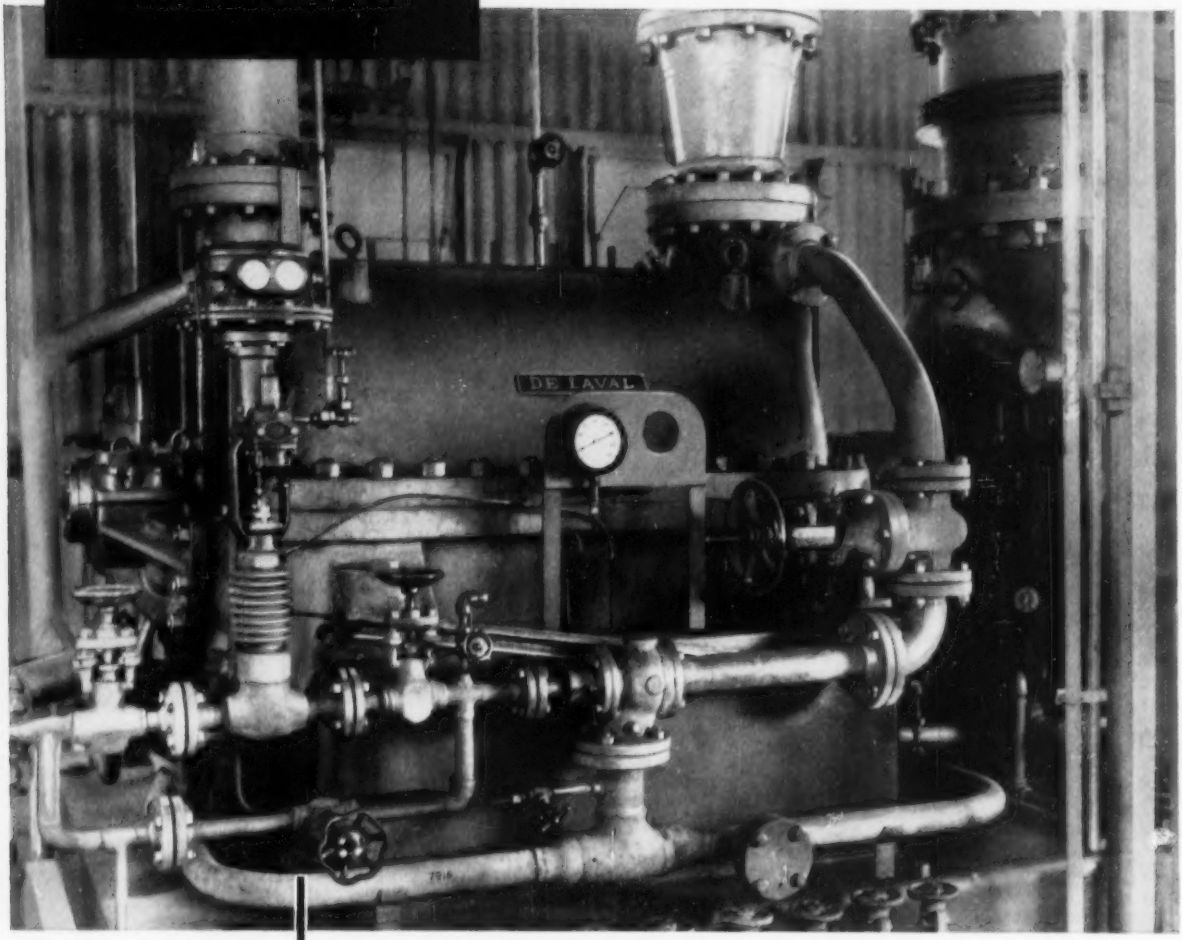
DE LAVAL CENTRIFUGAL COMPRESSOR

handles hydrocarbon gas in Sunray Oil refinery



Send for new Bulletin 0504

This De Laval 7-stage centrifugal gas compressor, installed at the Duncan, Oklahoma refinery of the Sunray Oil Company, handles a heavy hydrocarbon gas in a delayed coking process. The gas has a molecular weight of 31.5.

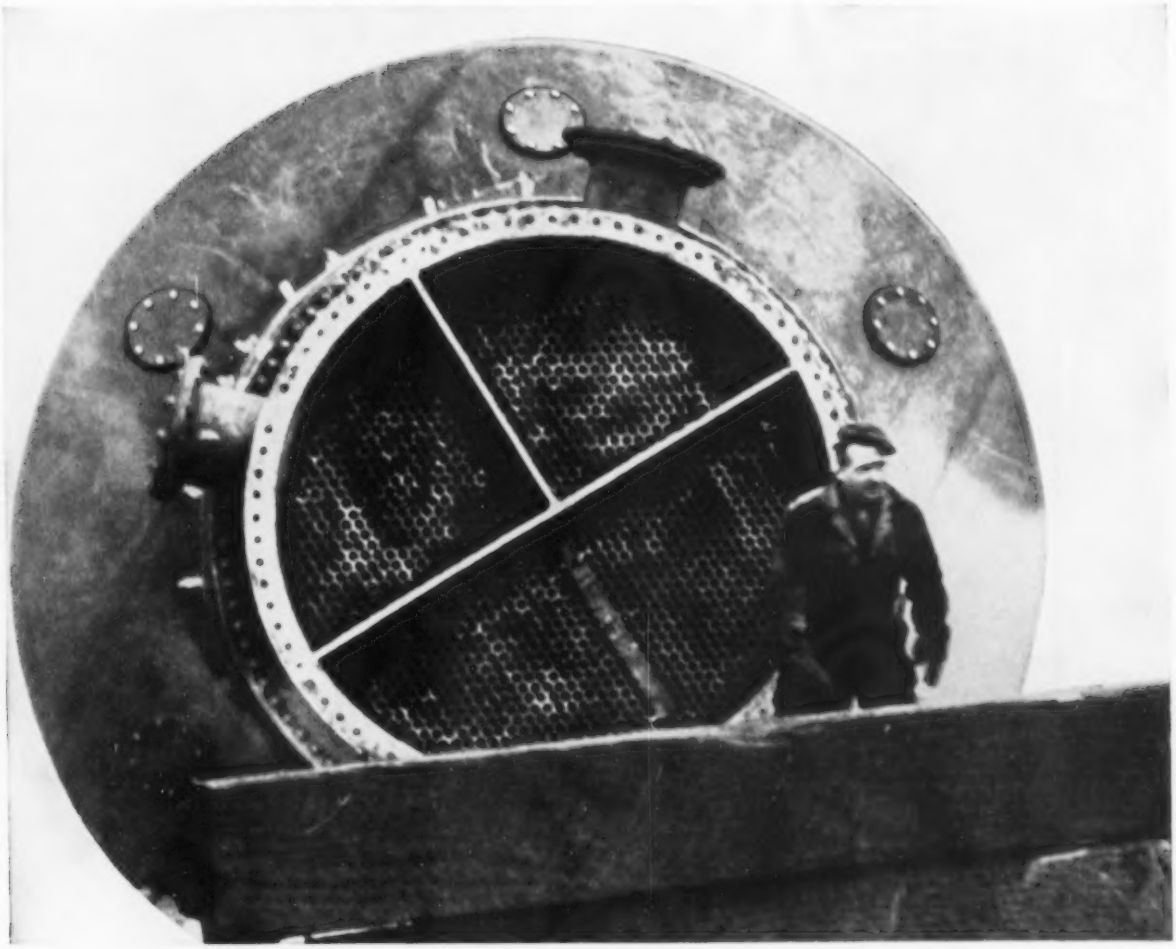
The De Laval centrifugal compressor is rated at 2840 inlet cfm; discharge pressure is 240 psia. The power required is 1350 bhp with compressor operating at 9900 rpm.

Sunray Oil is another refinery which has selected De Laval compressors for heavy-duty continuous service. Rugged, horizontally split casings, individually designed impellers, perfectly balanced rotors and externally mounted, cylindrically seated bearings are design features that assure optimum performance and long service.

DE LAVAL *Centrifugal Blowers*

DE LAVAL STEAM TURBINE COMPANY
811 Nottingham Way, Trenton 2, New Jersey

DL 327



5½ miles of cost-saving corrosion control with *Carpenter* Stainless Tubing

Nearly 30,000 feet of Carpenter Stainless Tubing are installed in this 35-ton surface condenser specially designed for condensing blow-down steam from digesters in a paper mill.

Cost-saving, trouble-free corrosion control is only one of the many advantages you get with Carpenter Stainless Tubing. The industry's top quality control processes assure an extra measure of uniformity, quality and perfection in every shipment. Faster, easier fabrication of Carpenter Stainless Tubing makes any tubing or re-tubing job more economical.

Ask your Carpenter Distributor for full information on the new non-destructive quality control test that assures better-than-ever quality in Carpenter Stainless Tubing.

MEMBER

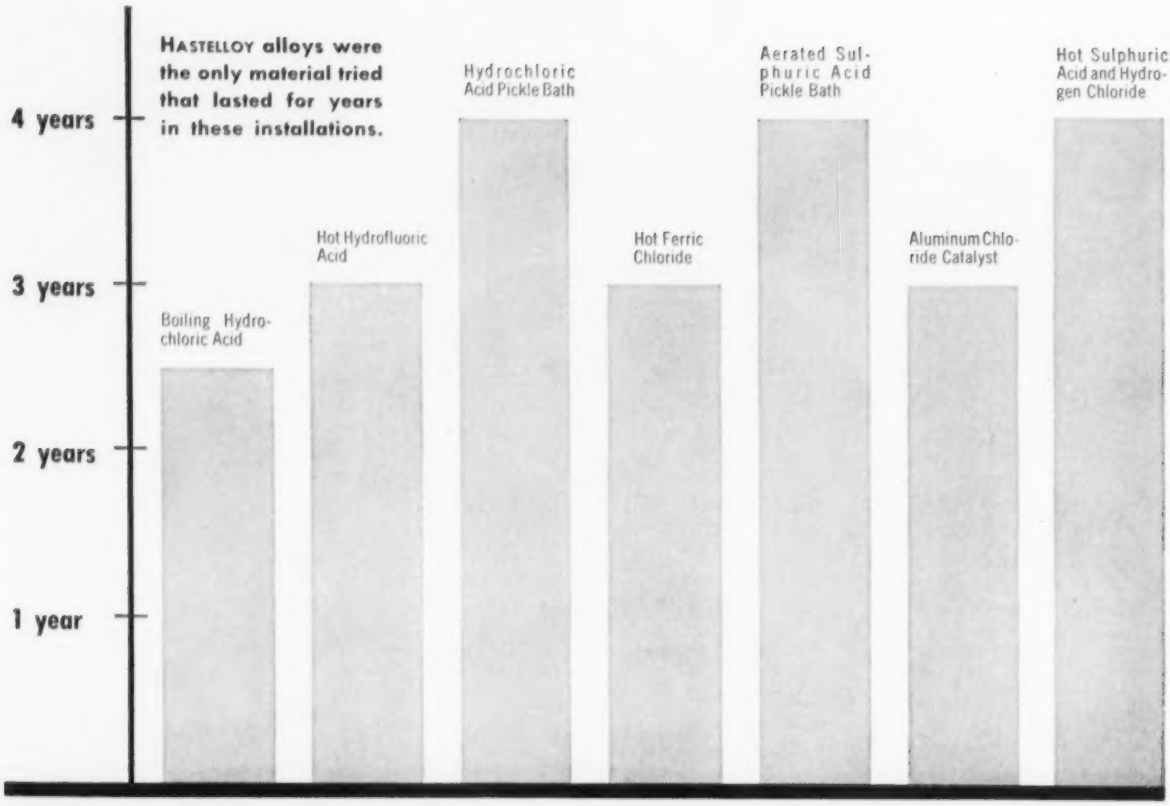
The Carpenter Steel Company
Alloy Tube Division, Union, N. J.

Export Dept.: The Carpenter Steel Co., Port Washington, N. Y.—"CARSTEELCO"

Carpenter

Stainless Tubing & Pipe

For more data on advertised products, use Readers' Service Cards, last page.


HASTELLOY alloys were the only material tried that lasted for years in these installations.
4 years
3 years
2 years
1 year
Boiling Hydrochloric Acid
Hot Hydrofluoric Acid
Hydrochloric Acid Pickle Bath
Hot Ferric Chloride
Aerated Sulphuric Acid Pickle Bath
Aluminum Chloride Catalyst
Hot Sulphuric Acid and Hydrogen Chloride

HASTELLOY Alloys *last for years under severe corrosive conditions*

These graphs were drawn from data on actual installations of HASTELLOY alloys in severe corrosive media. No other material tried lasted more than six months in most of these installations, some considerably less than this. HASTELLOY alloys lasted for years.

Use of HASTELLOY alloys saved time, money, and production time in all the installations. The graphs do not tell the entire story by any means. Some of the parts made of HASTELLOY alloys were still going strong when the data were obtained. In some, corrosion was complicated by abrasion, impact, and the presence of contaminants.

Samples for testing HASTELLOY alloys under actual operating conditions are available without obligation. Just let us know what corrosive conditions are involved. For a copy of a booklet describing HASTELLOY alloys, get in touch with the nearest Haynes Stellite Company Office.

HAYNES TRADE-MARK ALLOYS

HAYNES STELLITE COMPANY

A Division of Union Carbide and Carbon Corporation

UCC

General Offices and Works: Kokomo, Indiana

Sales Offices

Chicago · Cleveland · Detroit · Houston · Los Angeles · New York · San Francisco · Tulsa

"Haynes" and "Hastelloy" are registered trade-marks of Union Carbide and Carbon Corporation.

For more data on advertised products, use Readers' Service Cards, last page.

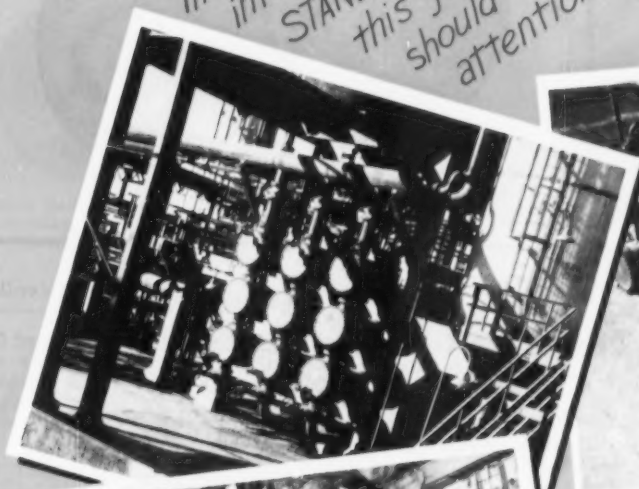
35 EXCHANGERS
6 DIFFERENT SERVICES
55,475 FT. OF SURFACE

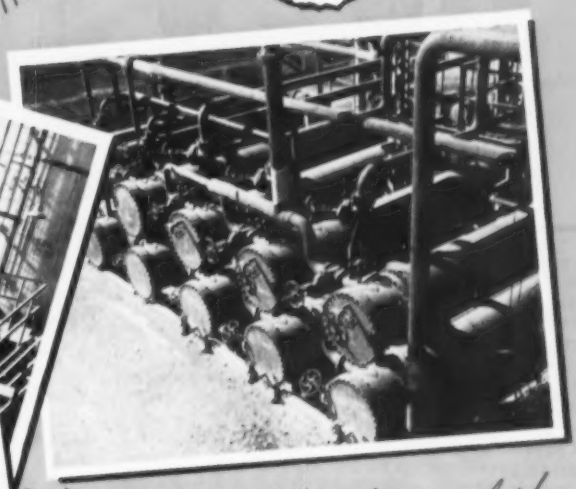
All interchangeable with 1 bundle!

This made sense to... so why not use it in an ad?

Phillips 66

NOTE: With increased interest in STANDARDIZATION this job should command attention!!





Here are the photos of the 35 exchangers

WESTERN HEAT EXCHANGERS

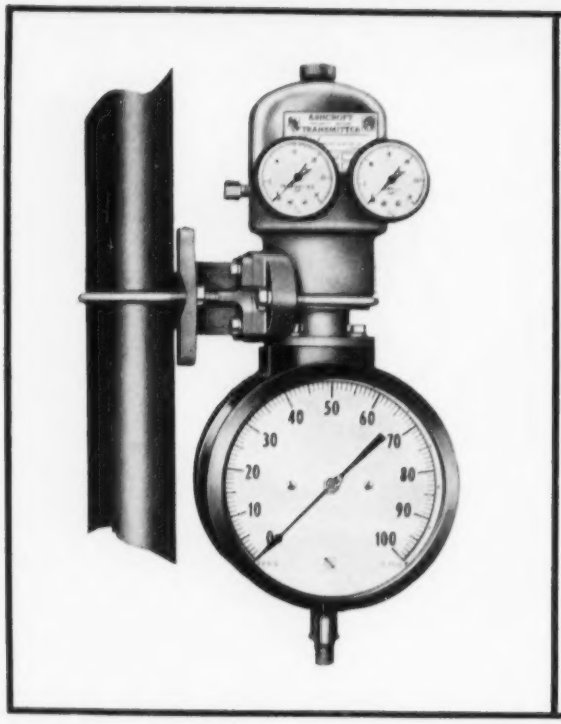
WESTERN SUPPLY COMPANY
P. O. BOX 1888 • TULSA, OKLAHOMA

HUDSON-RUSH COMPANY—753 Gladstone Blvd., Shreveport, La.
130 Casa Linda Plaza, Dallas 18, Texas
PROCESS INSTRUMENTS & EQUIP. CO.—North Bldg., Charleston, W. Va.
H. W. SEVERANCE—Marion E. Taylor Bldg., Louisville, Ky.

Use same sig

Designed to solve safety and service problems

...THE NEW ASHCROFT PNEUMATIC PRESSURE TRANSMITTER



This new Ashcroft Pneumatic Pressure Transmitter is particularly recommended to processing industries and power stations. It combines speed and accuracy with maximum protection and serviceability.

The new design features the 6" indicating Ashcroft Maxisafe Duragauge, long known for dependable performance. It has an integrally-cast solid metal wall between dial and pressure sensitive element so that the transmitter can measure pressures up to 100,000 psi with complete safety for personnel and equipment. If misapplication ruptures the Bourdon tube, the Teflon-coated back cover serves as a safety blowout relief.

Another outstanding design advantage is easy access to both gauge and transmitter sections. Simply remove the safety-relief back cover and both the gauge and transmitter can be calibrated. Yet a sealed housing makes the entire assembly weatherproof.

The transmitter operates on low-pressure air. No need for expensive high-pressure lines and fittings. Supply air pressure as low as 18-20 psi for 3 to 15 psi output provides especially advantageous operation where electrical wiring might be a hazard. Inflammable, poisonous or corrosive liquids or gases are confined close to their source, away from the central control point.

The Series 1250 Ashcroft Pneumatic Pressure Transmitter is available with pressure sensing elements in all standard pressure ranges and Bourdon tube materials. Installation of the transmitter is easy. Small diameter tubing may be used, and the pipe, stem, wall or flush mounts are interchangeable in the field. Get complete operational data and construction details. Write for Bulletin 340.

1850 ASHCROFT U.S.A.

YOUR INDUSTRIAL SUPPLY DISTRIBUTOR has the broad knowledge and thorough experience essential to satisfy every requirement of your Ashcroft Pneumatic Pressure Transmitter application. You get fast, economical service from his local stocks.

In Canada: *Manning, Maxwell & Moore of Canada, Ltd., Galt, Ontario*

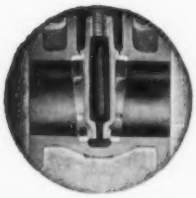
ASHCROFT GAUGES

MAXWELL MANNING MM&M TRADE MARK

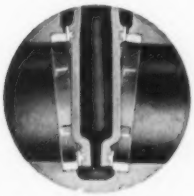
A product of **MANNING, MAXWELL & MOORE, INC.** STRATFORD, CONNECTICUT

MAKERS OF 'AMERICAN' INDUSTRIAL INSTRUMENTS, 'CONSOLIDATED' SAFETY AND RELIEF VALVES, 'AMERICAN MICROSEN' INDUSTRIAL ELECTRONIC INSTRUMENTS, *Stratford, Conn.* 'HANCOCK' VALVES, *Watertown, Mass.* 'CONSOLIDATED' SAFETY RELIEF VALVES, *Tulsa, Oklahoma.* AIRCRAFT CONTROL PRODUCTS, *Danbury & Stratford, Conn. and Inglewood, Calif.* "SHAW-BOX" AND 'LOAD LIFTER' CRANES, 'BUDGIT' AND 'LOAD LIFTER' HOISTS AND OTHER LIFTING SPECIALTIES, *Muskegon, Mich.*

For more data on advertised products, use Readers' Service Cards, last page.

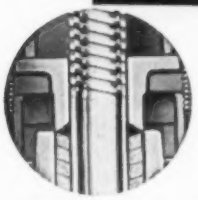


Straight-Flow Port Design reduces fluid turbulence to a practical minimum.



Seat Rings of end-seated type are screwed into the body.

Sure-Grip Malleable Handwheel for non-skid gripping even with heavy gloves.



Brass Liner on Glands assures greater resistance to corrosion and scoring.

WALWORTH

iron body gate valves

with screwed or flanged ends

... 8 Outstanding Features

For complete information on these new Walworth Iron Body Valves, see your local Walworth distributor, or write for bulletin 106.

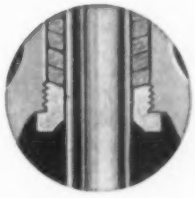
WALWORTH

valves and fittings

60 EAST 42nd STREET NEW YORK 17, N. Y.

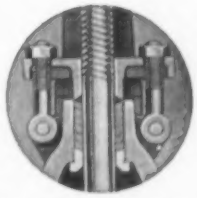
DISTRIBUTORS IN PRINCIPAL CENTERS THROUGHOUT THE WORLD

T-head Disc-to-Stem connection on OS&Y types provides stronger connection, prevents loosening of disc by corrosion.



Bronze Back-Seat Bushings in bonnets of OS&Y valves.

Solid Web Type Disc in OS&Y valves for greater strength and longer service.



Hinged Gland Eye-Bolts on OS&Y valves permit faster, easier repacking under full pressure.

FRAM-WARNER LEWIS

NEW VERTICAL SEPARATOR / FILTER

FOR WATER AND SOLIDS REMOVAL FROM LIQUID FUELS

- OPERATES ON LIQUID FUELS (JP-3, JP-4, JP-5, AVIATION GASOLINE, KEROSENE, DIESEL FUEL, NO. 2 FUEL OIL, SOLVENTS, AROMATICS, ETC.)
- REVOLUTIONARY FEATURES TO SIMPLIFY MAINTENANCE (SWING BOLT COVER WITH MECHANICAL LIFTING JACK, SCREW BASE CARTRIDGES)
- GOVERNMENT TESTED AND APPROVED — MEETS ALL CURRENT MILITARY SPECIFICATIONS
- MANUFACTURED BY WORLD LEADER IN FILTRATION AND SEPARATION
- DESIGNED FOR ANY CODE OR PRESSURE REQUIREMENT
- TOP EFFICIENCY ON WATER AND SOLIDS REMOVAL
- SPECIALLY DESIGNED FOR REFINERY, MARKETING, MARINE, AIR FIELD, AND GOVERNMENT APPLICATION

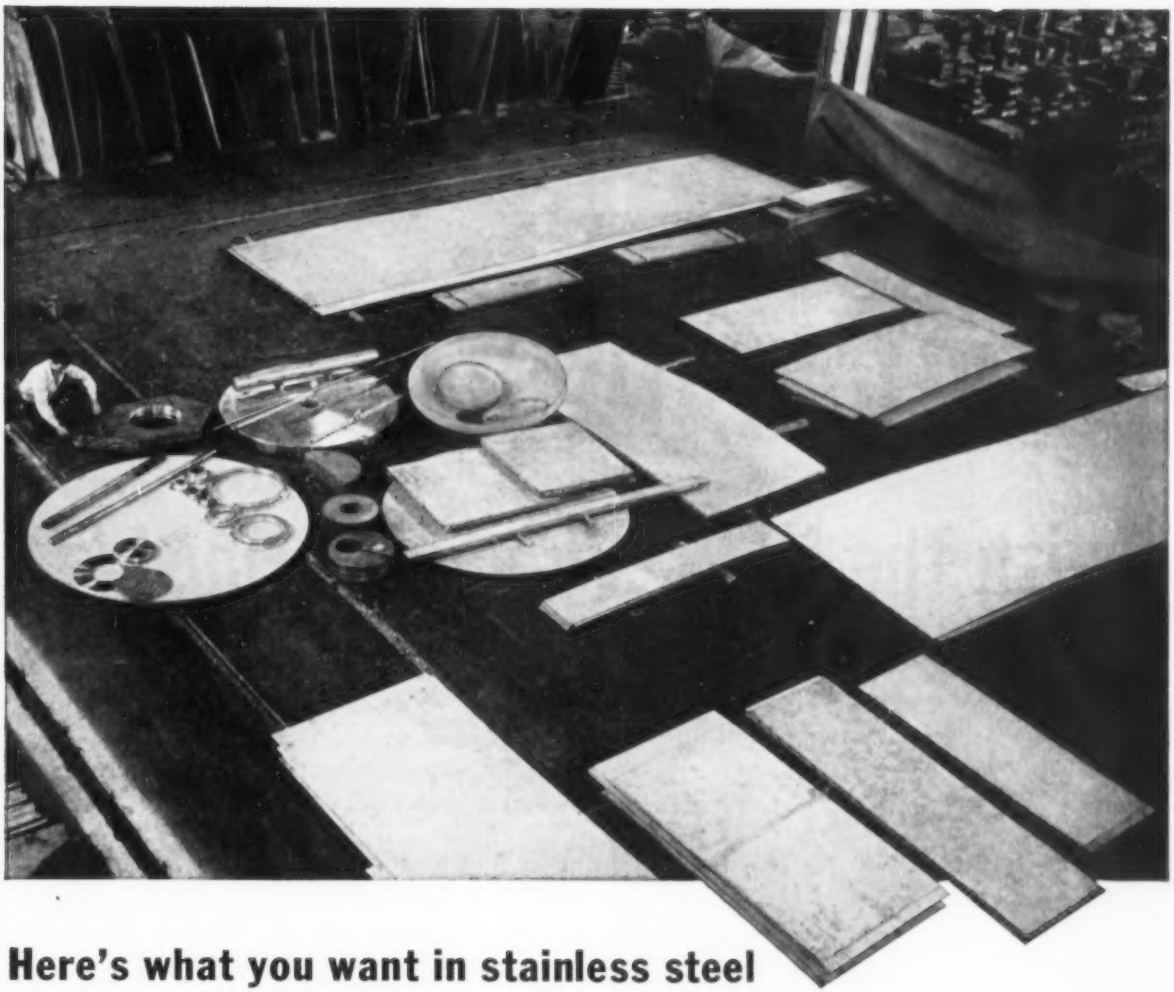
WARNER LEWIS COMPANY

BOX 3096 • TULSA, OKLAHOMA

DIVISION OF FRAM CORPORATION

REPRESENTATIVES IN MAJOR CITIES

WRITE FOR BULLETIN WL-5-56



Here's what you want in stainless steel —the way you want it

Stainless Steel Plate . . . produced to almost any size or thickness, 3/16" and heavier, in rectangles or cut-to-shape. Carlson maintains what is probably the largest stock of stainless plate in the country—produced to highest chemical and metallurgical standards—ready for cutting to your requirements, and for shipment when you want it.

Stainless Steel Heads . . . spun or press formed to your order or taken directly from our stock of ASME and Standard flanged and dished heads—the *largest stock* maintained anywhere. In addition to supplying heads for tanks, heat exchangers, condensers and similar equipment, Carlson can fill a complete bill of material including shell plates, flanges, rings, pads and other components.

Stainless Steel Forgings, Circles, Rings, and Special Patterns . . . Flanges, circles, rings, and sketch plates are cut from plate, or forged and rough machined to meet your specifications.

Stainless Steel Bars and Sheets (No. 1 Finish)

Complete Service . . . At Carlson the emphasis is on flexibility, efficiency and economy in producing what you want, when you want it. If you would like additional information about our service and products or, if you want *to place an order*—just let us know, we promise you prompt action!

write for CARLSON'S WEEKLY STOCK LISTS . . . YOUR GUIDE TO WHAT'S AVAILABLE IN QUALITY STAINLESS STEEL

Stainless Steels Exclusively

G. O. CARLSON, INC.

THORNDALE, PENNSYLVANIA

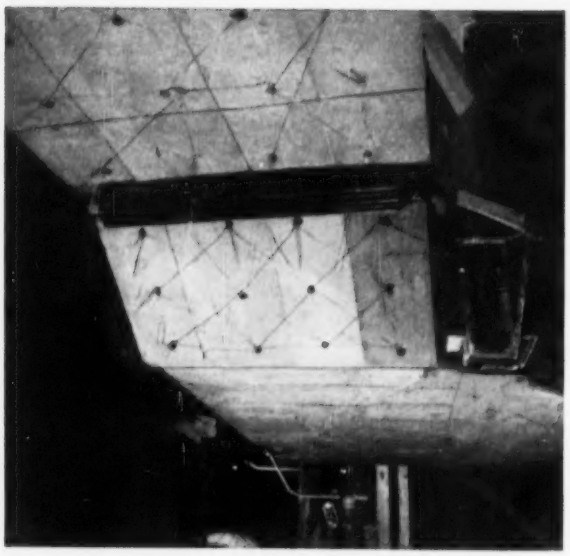
Plates • Plate Products • Forgings • Bars • Sheets (No. 1 Finish)

District Sales Offices in Principal Cities

For more data on advertised products, use Readers' Service Cards, last page.

EAGLE-PICHER
PV SUPERTEMP
BLOCK INSULATION

with the NEW *"Precision-Finish"*



A TRUE-CUT BLOCK! Eagle-Picher's new "precision-finish" is one of the most important insulation developments in years. Here's a highly efficient, all-purpose insulating block that is practically dustless.

GREAT STRUCTURAL STRENGTH! Eagle-Picher PV Supertemp Block meets your specific demands for long-lasting insulating block able to withstand a wide hot surface temperature range up to 1900 F. PV Block effectively resists steam and other moisture, does not disintegrate or lose thermal efficiency under heavy-duty service.

EASILY INSTALLED! Lightweight PV Supertemp Block is easy to handle, requires only minimum reinforcing. It is easily cut to fit irregular areas—and no special tools are needed.

WRITE FOR FREE SAMPLE TODAY!

Compare Eagle-Picher PV Supertemp Block with other insulating blocks. You'll appreciate the improved temperature control that pays off in greater fuel savings. You'll sell yourself on the new "precision-finish"!

Since 1843

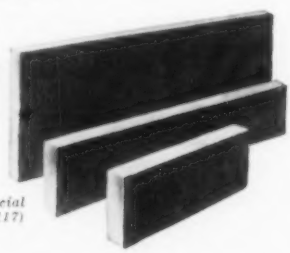
EAGLE EP PICHER

THE EAGLE-PICHER COMPANY

Producing a complete line of industrial insulations

Cincinnati 1, Ohio

(Member of Industrial Mineral Fiber Institute)



(Conforms to Commercial Standard CS 117)

TRUFIN*

SAVES YOU MONEY

8 WAYS

Anytime you cut down costs, you pep up the profit picture. Here's an idea: where heat exchange costs are concerned, Wolverine Trufin Type S/T—the integral finned condenser tube—can help you save money *eight* ways. Take a look at the points listed below. They can open the door to substantial savings, provide added dividends in increased efficiency.

✓ Because Trufin is an extended surface tube—with fins extruded right from the tube wall—it has more than twice the heat transfer surface of plain tube. Less tube is required because Trufin transfers more BTU's per foot of tube.

✓ Fewer tubes mean smaller shells, headers, baffles, etc. This saves material requirements.

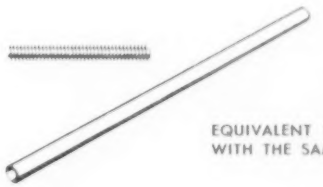
✓ Fewer tubes mean fewer holes to drill—less rolling-in operations. Direct result: substantial savings in labor costs.

✓ To transfer a given heat load—when Trufin is used—much less weight of over-all tube metal is required. This is a real saving when expensive alloys are necessary. This is of greatest importance when alloys are in short supply, as a given quantity of metal in Trufin transfers much greater heat loads.

FEWER TUBES
MEAN SMALLER SHELLS

✓ Because of these material savings, lighter units—requiring less structural support—can be designed. This is vital when exchangers are to be mounted on superstructures.

✓ Maintenance costs are low. Costs of replacement tubes are reduced; fewer tubes result in less cleaning time, more "on stream" time. Actual operating data proves that Trufin withstands fouling for longer periods than does prime surface tube. This increases the length of operating time between change-overs.



EQUIVALENT TUBES
WITH THE SAME SURFACE

✓ Smaller, lighter units result in easier handling and lower shipping costs.

TRUFIN
MEANS
SMALLER
UNITS

✓ Where space is at a premium—as in revamped units—Trufin units are smaller.

There they are—eight job-proven ways in which Wolverine Trufin Type S/T condenser tube can save you money. Wolverine's Trufin Opportunity Book is filled with actual Trufin case histories, operating data, valuable design information. Write for your copy today. WOLVERINE TUBE, 1437 Central Avenue, Detroit 9, Michigan.

Wolverine Trufin available in Canada through the Unifin Tube Company, London, Ontario.

WOLVERINE TUBE

Division of Calumet & Hecla, Inc.

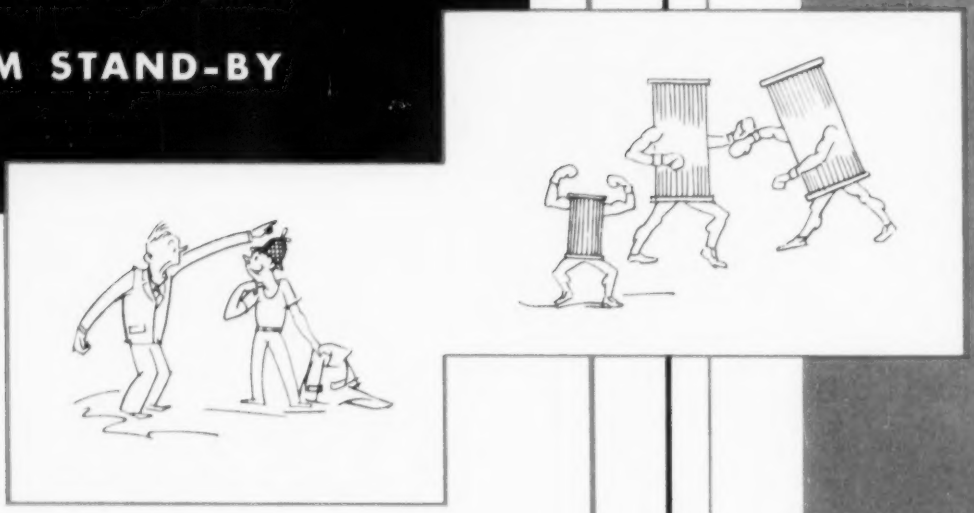
MANUFACTURERS OF QUALITY CONTROLLED TUBING AND EXTRUDED ALUMINUM SHAPES

*REG. U. S. PAT. OFF.

PLANTS IN DETROIT, MICHIGAN, AND DECATUR, ALABAMA. SALES OFFICES IN PRINCIPAL CITIES

EXPORT DEPARTMENT, 13 EAST 40TH STREET, NEW YORK 16, NEW YORK

THE CASE OF THE BANTAM STAND-BY



"There was no doubt about it. Paul Jones was completely dumbfounded." "Just a minute," he screamed. "Do you mean to stand there and tell me that undersized little condenser is your stand-by unit? It's impossible. It's almost a third smaller than your on-stream units. It couldn't possibly carry the same heat load when you switch over."

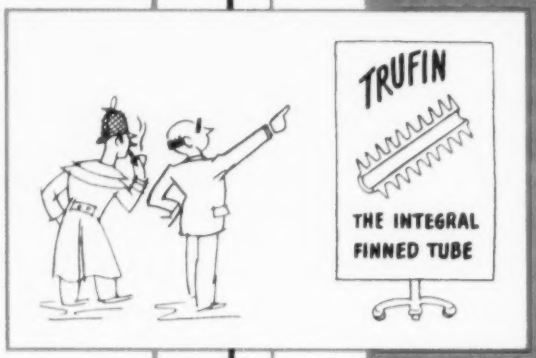
"I couldn't help laughing to myself. Paul is a processing engineer—a good one, too. Home-office had sent him out to see just how come we were able to out-produce the east-coast plant. Basically, both installations are the same—but for the past year our production records have been away ahead of theirs. I had him out on an inspection trip—showing him our set-up.

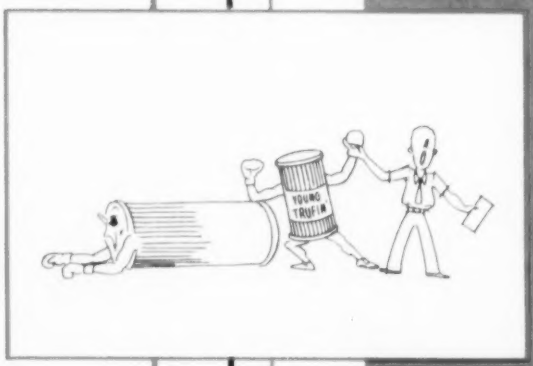
"Paul", I said, "you'd make a good private eye. You spotted that size differential fast! Strange as it seems—that's the secret of our high production. It all started about the time this plant first went on stream. A Wolverine salesman was making a call just as I was going over the prints for our stand-by unit."

"Look," he said. "On this job, if you use Wolverine Trufin —the integral finned tube—you can design a smaller unit. Trufin is an extended surface tube with its fins extruded right from the tube wall. It has over twice the surface area of prime surface tube. As a result you get increased heat duty from a smaller unit plus a substantial saving in tubing costs."

"Well, we designed the stand-by around Trufin Type S/T—and it worked just like he said it would. Naturally ever since then, when we pull a unit for retubing, we use nothing but Trufin Type S/T. That increased heat transfer surface is boosting our capacity—that's why our production has been ahead of yours."

And there you are! To achieve exactly the same kind of results in your own processing installation, specify Wolverine Trufin Type S/T. Write, too, for your copy of the Trufin Opportunity Book—64 pages—full of actual Trufin case histories and helpful design information.





WOLVERINE TUBE, 1437 Central Avenue, Detroit 9, Michigan.

WOLVERINE TUBE

Division of Calumet & Hecla, Inc.

MANUFACTURERS OF QUALITY CONTROLLED TUBING AND EXTRUDED ALUMINUM SHAPES

PLANTS IN DETROIT, MICHIGAN, AND DECATUR, ALABAMA. SALES OFFICES IN PRINCIPAL CITIES

EXPORT DEPARTMENT, 13 EAST 40TH STREET, NEW YORK 16, NEW YORK

. . . there's enough difference to make ALL the difference

This is just one inspection of extrusion dies through which a cast billet heated to a rigidly controlled temperature is hot extruded into a "tube shell" . . . from which Scovill Heat Exchanger Tube is subsequently cold-drawn.

One of the most highly skilled and critical jobs in the process is that of finishing and maintaining these dies. The smooth, clean surfaces of resulting shells are essential assurance of highest quality in finished tubes.

It is needless to tell Scovill customers that, while *correct alloy selection* is important to efficient exchanger operation, of equal importance is the *uniformity and soundness of tubes* themselves. Scovill Technical Service and tube production methods, considered by many the very best in the industry, can give you complete assurance on both these essential counts.

Scovill Heat Exchanger Tube is available in a comprehensive range of standard alloys (listed below).

Scovill Manufacturing Company, Mill Products Division,
99 Mill Street, Waterbury 20, Connecticut. Phone Plaza 4-1171.

SCOVILL **HEAT EXCHANGER TUBE**

Phosphorized Admiralty • Admiralty • Arsenical Admiralty • Muntz Metal • Naval Brass • Red Brass 85% • Deoxidized Copper
Arsenical Copper • Copper Nickel, 10% & 20% • Cupro Nickel, 30% • Aluminum Brass • Aluminum Bronze, 5% • Duplex Tube

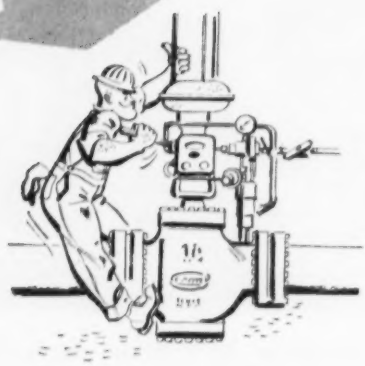
18C56

For more data on advertised products, use Readers' Service Cards, last page.

YOU SAY GO!

When you call MECO for MASONEILAN EQUIPMENT

You avail yourself of qualified, resourceful MECO Engineers to assist you in selection of suitable Masoneilan Control Equipment.



The shop adjusted and tested Masoneilan equipment is followed through to final installation by competent MECO service.

Masoneilan diaphragm control valves, liquid level controls and instruments for controlling pressure, flow and temperature available from large Houston stocks.

MASONEILAN

When you want action call

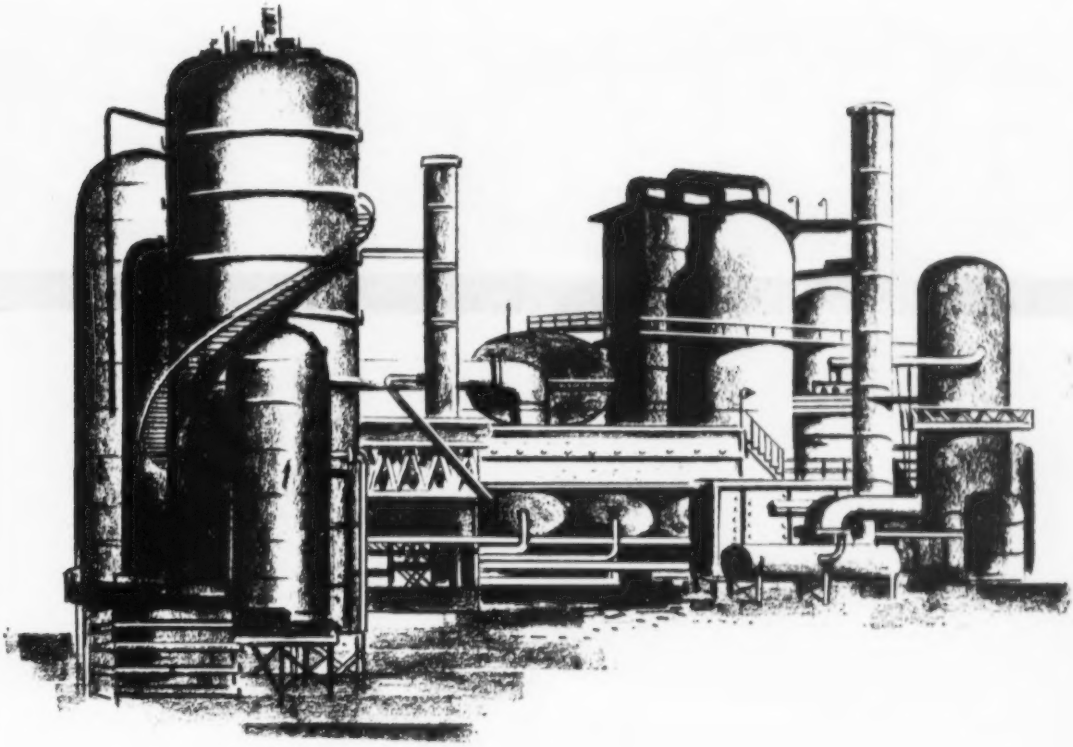
CA 7-3135

MECO

MAINTENANCE *Engineering* **CORPORATION**

P. O. BOX 2637

3711 CLINTON DRIVE
HOUSTON, TEXAS

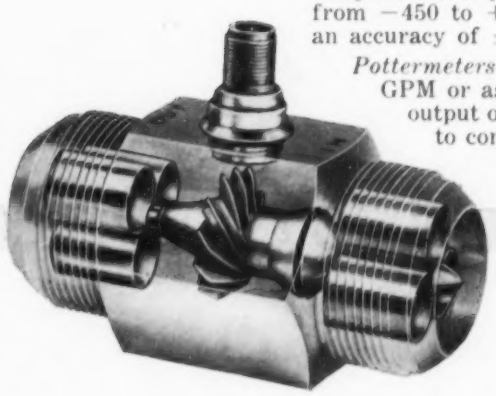


FOR VITAL FLOW CONTROL

WHETHER you're developing a new process or modernizing an old one—investigate the unique characteristics of the bearingless *Pottermeter*.

This electronic flowmeter—easily installed in any type of piping to operate at any angle, at any pressure and at temperatures from −450 to +1200°F, measures flow of any liquid with an accuracy of ±½ of 1%.

Pottermeters are available to measure flows as low as 0.07 GPM or as high as 3,000 GPM. The inherently linear output of the *Pottermeter* makes it ideal for systems to control either flow rate or total flow.



Find out how the bearingless "floating rotor" used in the *Pottermeter* can give you more precise flow measurement, longer trouble-free service life, and more accurate flow control.

Write for Bulletin PS-1

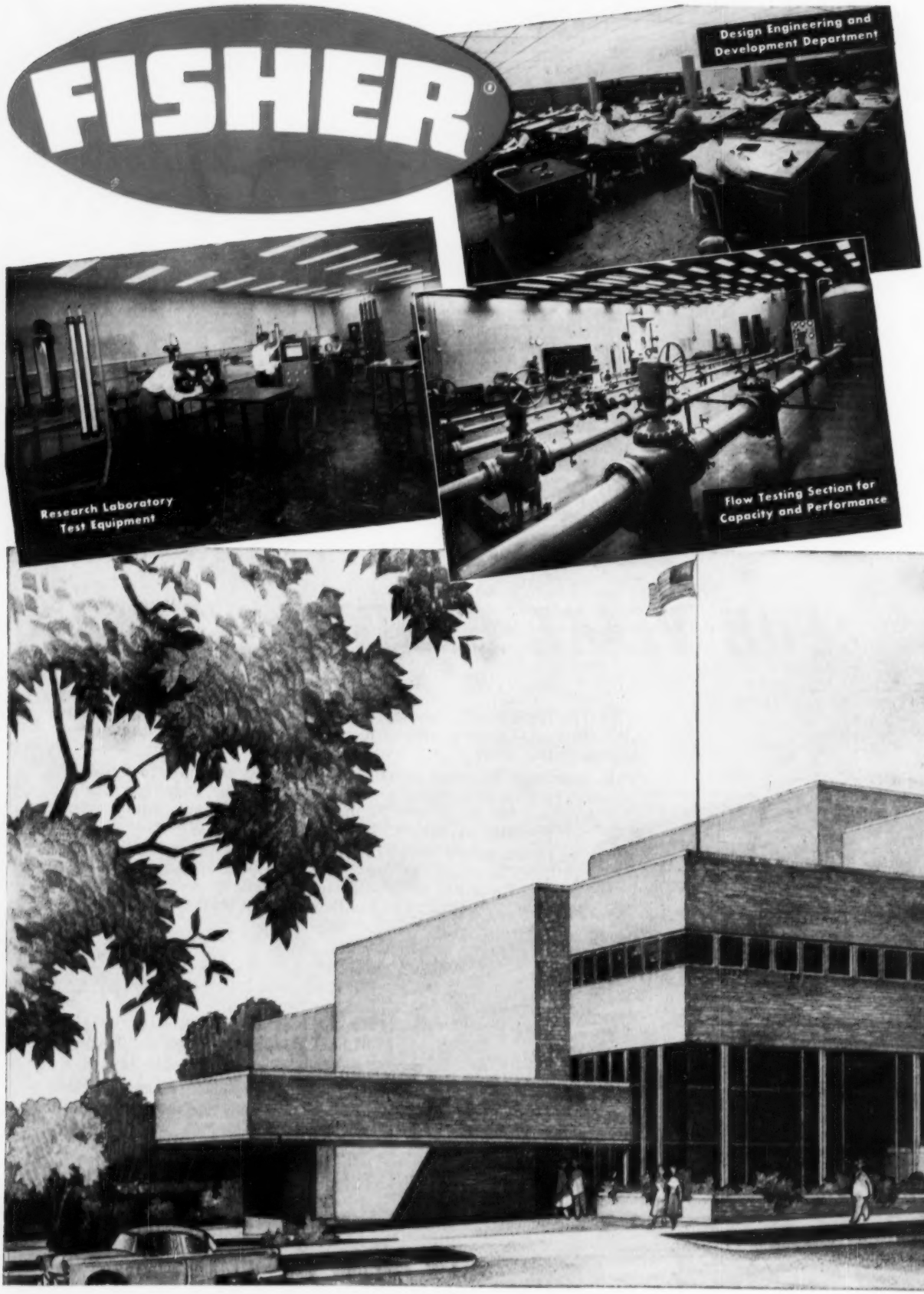
Potter

POTTER AERONAUTICAL COMPANY

Route 22 • Union, New Jersey • Phone MUrdock 6-3010

Makers of "Potter Engineered" products

For more data on advertised products, use Readers' Service Cards, last page.


FISHER
Design Engineering and Development Department
Research Laboratory Test Equipment
Flow Testing Section for Capacity and Performance

to Serve You Better . . .

Fisher Governor Company has built the industry's most modern and completely equipped engineering, research and administration building.

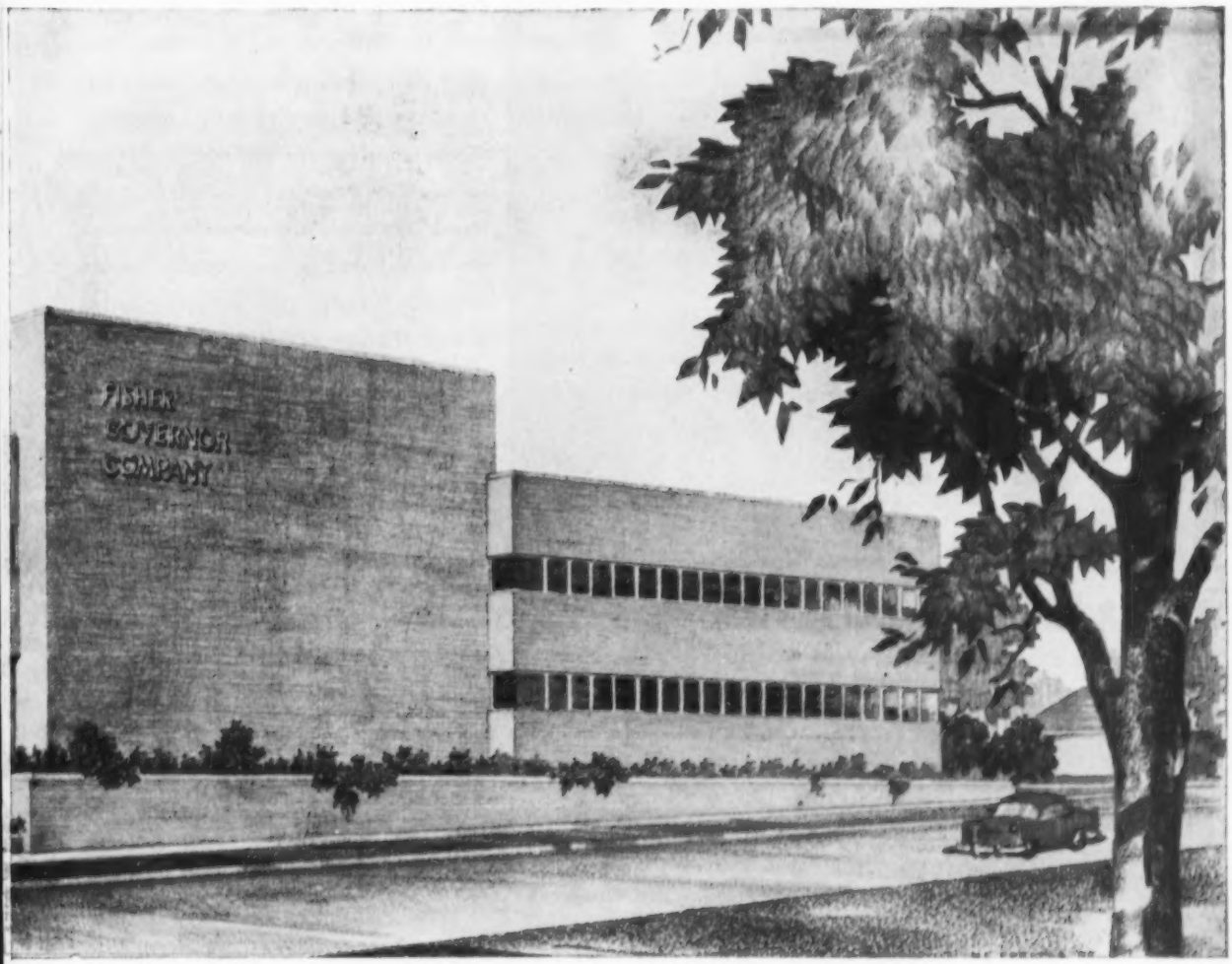
These new facilities—occupying over 100,000 square feet of space—make possible better coordination and greatly expanded engineering and research activities, so as to provide you the world's finest automatic control equipment. A series of test lines up to 12" diameter are located in the research laboratory. Performance tests are run on Fisher products at pressures up to 2500 psi, using air or water as flowing medium.

The enlarged product engineering department is located adjacent to the research laboratory area. Sales engineering and administrative offices are also in the new building.

FISHER GOVERNOR COMPANY • MARSHALLTOWN, IOWA

CANADIAN PLANT: WOODSTOCK, ONTARIO

WORLD LEADER IN RESEARCH FOR BETTER PRESSURE AND LIQUID LEVEL CONTROL



For more data on advertised products, use Readers' Service Cards, last page.

Announcing **A NEW LINE OF**

R&S

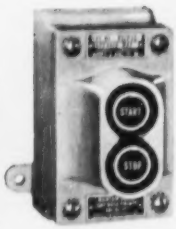
EXPLOSION-PROOF and DUST TIGHT

PUSH BUTTON and SELECTOR SWITCH STATIONS

EFS and HEFS TYPES

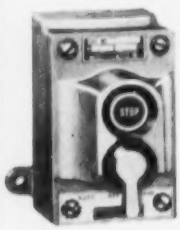
For Surface Mounting

(Class I, groups C & D)



EFS—213
HEFS—213

EFS—223
HEFS—223



EFSIS—W116
(Push button and selector switch)
HEFS—W115
(Selector switch)

Two new product lines of Explosion-Proof and Dust Tight push button and selector switch stations are now available in surface mounting types for control circuits of 600 Volts A.C. maximum, for use in hazardous locations Class I, Groups C & D. Both Standard Duty (EFS) and Heavy Duty (HEFS) types are furnished in a variety of single and two element stations — single or double push button, single selector switch, or single push button and selector switch units as illustrated — offered in button operated or rocker arm actuated mechanisms. All interiors are interchangeable.

Russell & Stoll announces a new line of compact Standard Duty EFS and Heavy Duty HEFS push button and selector switch stations, designed to give long trouble-free service under severe operating conditions in hazardous locations • Standard Duty and Heavy Duty single and two element stations can be furnished in multi-gang or tandem units and in combination with other Russell & Stoll EFS devices • Both EFS and HEFS lines include stations with either push button operation or rocker arm control mechanisms—the rocker arm actuated types assure smooth, non-freezing operation under corrosive conditions.

Write for literature 2156-53

SPECIFY **R & S EXPLOSION-PROOF EQUIPMENT** *— A Complete Line...Your Complete Safeguard!*

Lighting Fixtures and Fittings • Boxes • Breathers and Drains • Swivel Type Fixture Fittings • U-Pul Connection Boxes • Delayed Action Plugs and Receptacles • Interlocked Switch Receptacles and Plugs • Circuit Breakers • Switches • Combination Starters • Magnetic Starters • Pilot Lights • Push Buttons • Receptacles and Circuit Breaker Combinations • Panelboards, Standard and Custom-built • Multi-Gang Control Stations, all types.

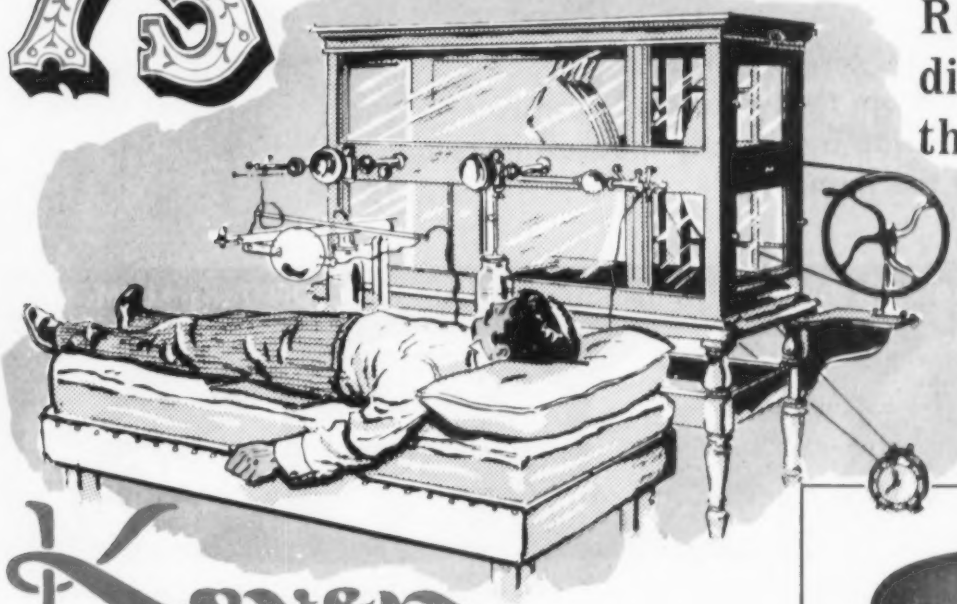
RUSSELL & STOLL COMPANY, INC. • 125 BARCLAY STREET, NEW YORK 7, N.Y.

D21

RUSSELL & STOLL

PRECISION-BUILT ELECTRICAL EQUIPMENT — SINCE 1902

75 years ago and 14 years before Roentgen discovered the x-ray

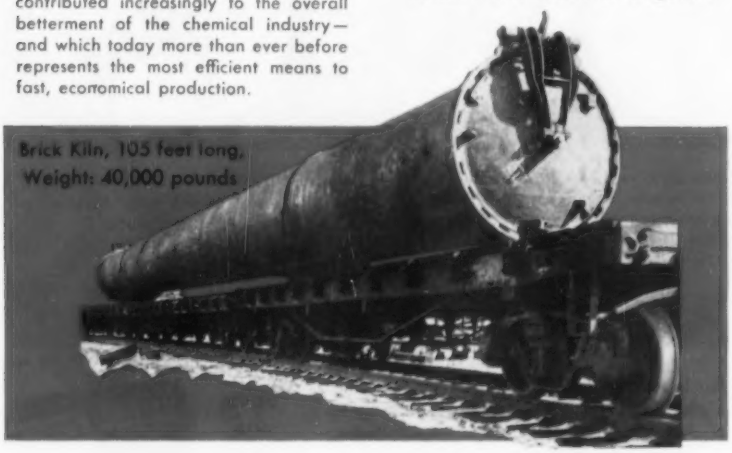


Koven was making individualized chemical equipment

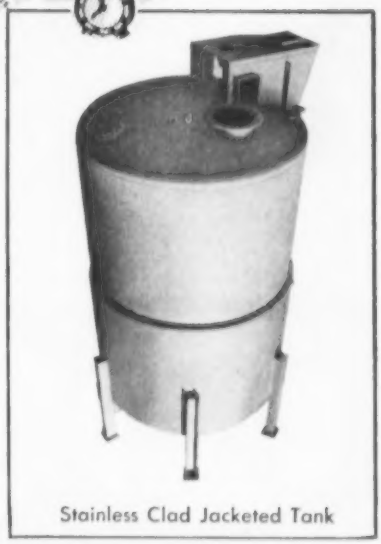
Industry—like science—grows in short progressive leaps . . . depends, for its survival and increase, on such specialized developments as the x-ray and individualized chemical equipment.

That's why, as far back as 1881, the chemical industry began profiting through the use of KOVEN Individualized Equipment—equipment which has since contributed increasingly to the overall betterment of the chemical industry—and which today more than ever before represents the most efficient means to fast, economical production.

For individualized equipment built to fit your exact specifications, call or write for a consultation with a trained KOVEN representative, and send for Bulletin #550. There's no obligation.



Brick Kiln, 105 feet long.
Weight: 40,000 pounds



Stainless Clad Jacketed Tank

X-RAY INSPECTION FOR QUALITY CONTROL

KOVEN equipment in all metals and alloys includes: High pressure vessels built to A.S.M.E., A.P.I. Codes; extractors; mixers; stills; kettles; tanks; stacks; breechings; hot transfer lines; light and heavy fabricated piping and plate exhaust ducts. Shop and field erected storage tanks to 2 million gallons. High vacuum testing on liquid oxygen storage tanks.

SPECIALISTS IN INTRICATE FABRICATION USING:
• STAINLESS STEEL • ALUMINUM • MONEL • NICKEL • INCONEL
• ALL CLAD MATERIALS Fabrication to all A.S.M.E. Codes

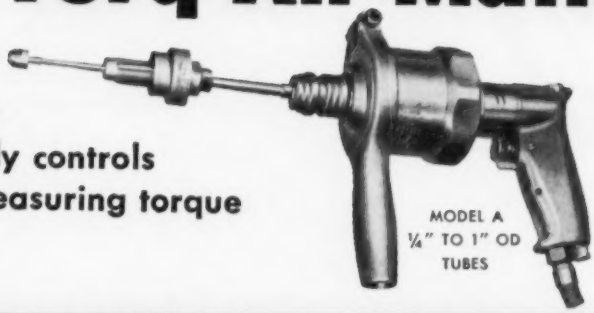
Koven *FOR INDIVIDUALIZED EQUIPMENT SINCE 1881*

L. O. KOVEN & BRO., INC. • 154-P OGDEN AVE., JERSEY CITY 7, N. J.
***PLANTS*: JERSEY CITY, N. J. • DOVER, N. J. • TRENTON, N. J.**

For more data on advertised products, use Readers' Service Cards, last page.

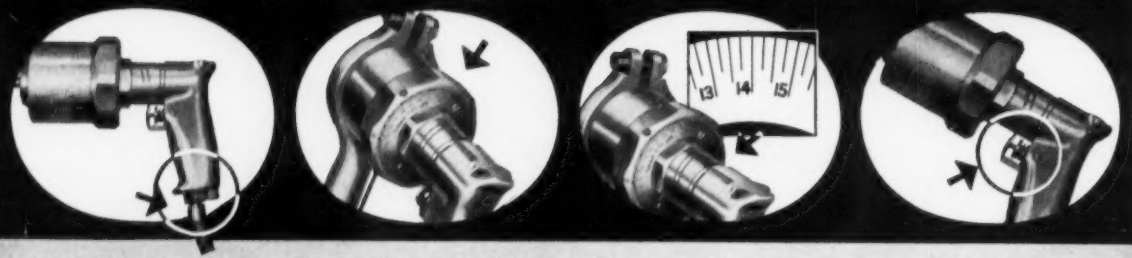
New WILSON Torq-Air-Matic

First and only air-driven tube expander drive that accurately controls tube expansion by directly measuring torque output at the mandrel.



MODEL A
¼" TO 1" OD
TUBES

Look at these exclusive design features of the WILSON Torq-Air-Matic

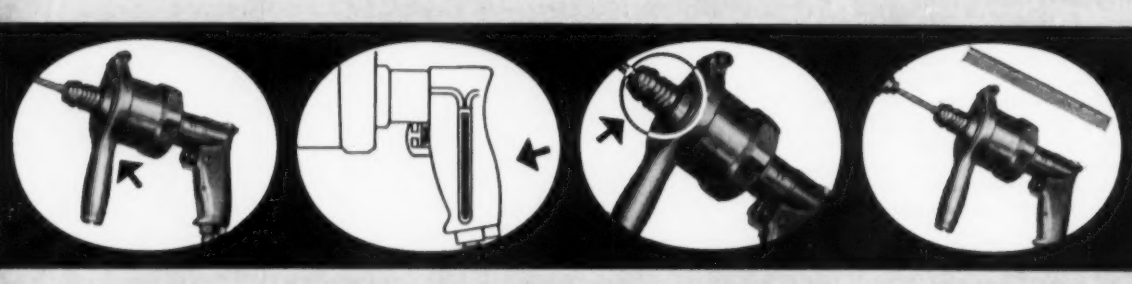


AIR-DRIVEN—Only air-driven tube expander drive with a built-in torque control. *Does not require a separate control box, relays or switches.* No extra cables or wires; just one small air hose serves it.

CALIBRATION—The only tube expander control calibrated *in terms of foot pounds torque instead of meaningless arbitrary units.* Torque requirements for expanding tubes of off-standard jobs can be more readily arrived at.

POWERFUL—Rated to deliver *fourteen foot pounds torque* at 90 psi. This is sufficient to roll 1" OD x 11 gauge boiler tubes.

SIMPLE—Only a *single three-position trigger throttle* for off, forward and reverse. Never any danger of over-rolling because of improper sequence of operation. No juggling of switches; nothing new to learn.



CONVENIENT—*Furnished with an auxiliary handle that can be swivelled to any position desired* by the operator or left off when the torque reaction is not too great. Basic unit is of a pistol grip design.

TROUBLE-FREE—*Has an oil reservoir* built into the handle to supply lubrication to the motor. *The control section is independent of the motor and lubricated for life.*

CHUCK—*Simple, new type, snap on floating chuck. Only one motion* instantly engages or disengages a square shank mandrel—no set screws.

COMPACT—*Only 10" overall* from pistol grip handle to instant action chuck.

TW 860

These features speak for themselves. The Wilson air-driven Torq-Air-Matic tube expander drive and control is an important revolutionary advance in the field of precise tube expanding. Here's what you get when you use the Wilson Torq-Air-Matic control for heat exchanger tubes: (1) uniform and tight pressure joints, regardless of tube sheet hole variation; (2) no over-rolled or under-rolled tubes—no stresses that shorten tube life; (3) extended tube expander life, more production, higher profits.

SEND FOR BULLETIN 55

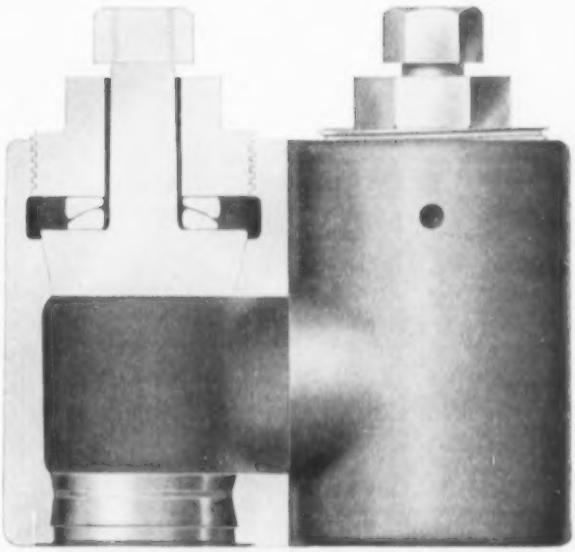
THOMAS C. WILSON, INC.

21-11 44th Avenue, Long Island City 1, New York • Representatives in all principal cities

MANUFACTURERS OF TUBE CLEANERS, TUBE EXPANDERS AND TUBE MAINTENANCE TOOLS

OHIO'S ANNOUNCING

THE ALL-NEW
OHIO TYPE 1500
RETURN BEND



OHIO TYPE 1500 RETURN BEND
(Patent applied for)

HEADING UP OPERATION

SELF-CONTAINED CLOSURE MECHANISM; all parts handle as a unit when heading up or unheading.

UNHEADING . . . FAST!

POSITIVE PLUG PULLER DEVICE incorporated in closure mechanism.

NO PULLING TOOLS REQUIRED. One wrench backing off set collar also serves as a plug puller. Set collar is backed off until it becomes engaged with standard hex nut on plug stem. Additional turn of set collar forces release of plug while threads are still engaged.

SAFE!

SAFETY FEATURE: Plug cannot blow out. Trapped gases relieved through weep-holes while set collar is still engaged in fitting.

STRENGTH OF CLOSURE DESIGN

Uniform stress in tension and shear about holding mechanism and body casting at all times. Floating set collar eliminates thread galling and/or thread seizure, thus insuring easy removal. Convex and concave surfaces of the equalizing rings assure proper alignment between set collar and plug.

BENDING OF SET COLLAR ELIMINATED BY 360° PROJECTION AND BEARING!

FOUR SERIES

850-1275-1700-2000

TEN SIZES IN EACH SERIES

2" to 6-5/8"

Write for information and prices

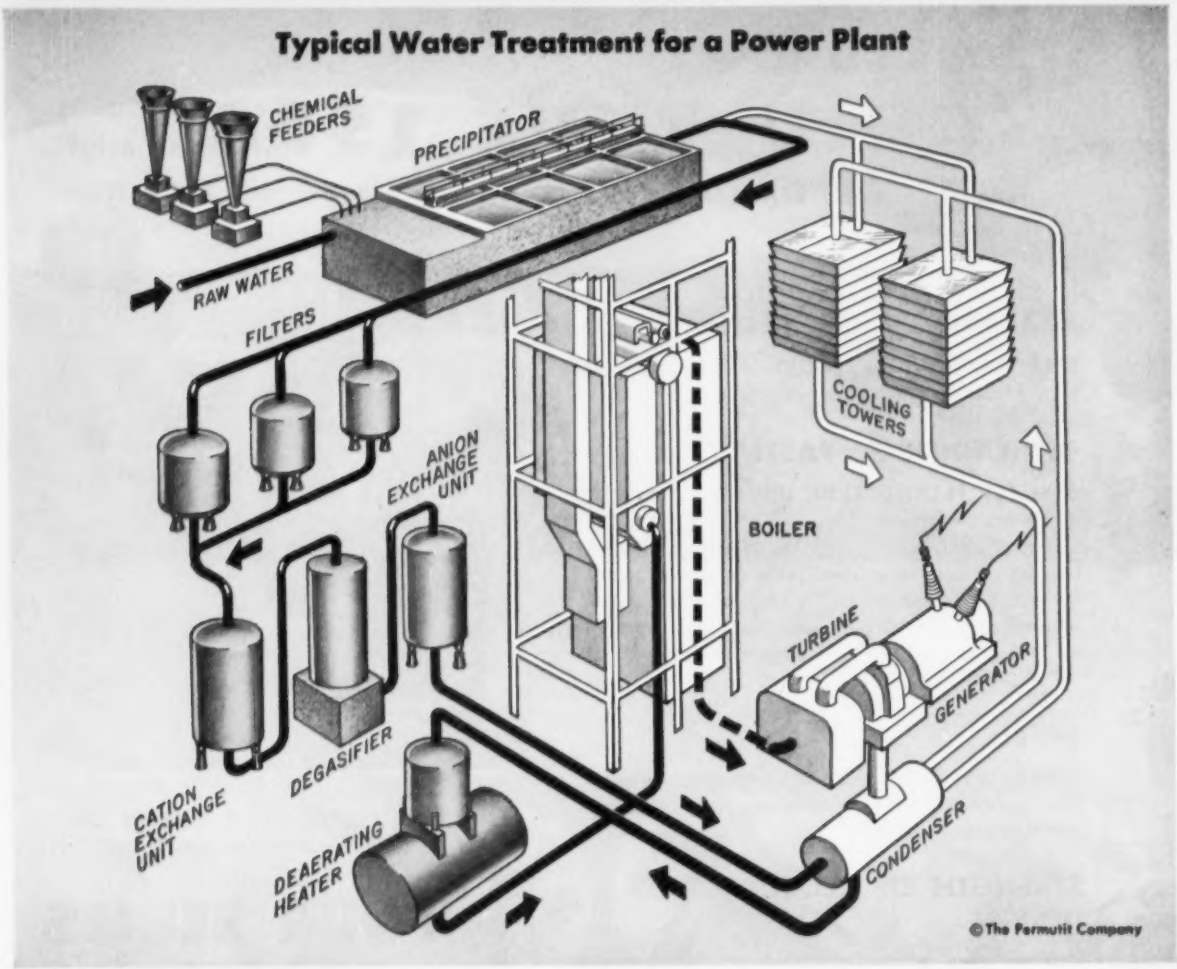
THE OHIO STEEL FOUNDRY COMPANY

ENGINEERS • FOUNDERS • MACHINISTS • FABRICATORS

LIMA, OHIO Plants at Lima and Springfield, Ohio

WATER:

Modern power plants require "ultra-pure" water for their high-pressure boilers. To provide it . . . new equipment produces the equivalent of commercially distilled water . . . at far lower cost!



99.99998% Pure Water for Power

Ordinary water with just the dirt and hardness removed was good enough for old-time boilers. But today's efficient plants operate at high steam pressures . . . up to 2600 psi. Future plants will operate at 5000 psi. and up!

● **At high pressures *any*** mineral element in the water causes trouble. For example: The few parts per million of dissolved silica in practically all water, while harmless for drinking, builds up as a glass-like deposit on turbine blades . . . impairs the balance and efficiency of the turbine.

● **Simplified flow sheet** shows how a muddy river water might be conditioned: The **Precipitator,** with coagulants and other chemicals from the **feeders,** takes out mud, most suspended matter and hardness. (This clarified water is adequate for the cooling-water system . . . cooling tower, condenser.) Next—the **filters** remove final traces of suspended matter. The **cation exchanger** takes out metallic ions (calcium, magnesium, sodium, iron, etc.). The **degasifier** removes carbon dioxide (formed in the cation exchanger). The **anion exchanger** takes out chlorides, sulfates, etc. and silica. The **deaerating heater** preheats the water for the boiler and removes corrosive gases.

Depending on the condition of the raw water and the type of demineralizer, total solids are often reduced to less than 0.2 parts per million!

● **Oldest and largest** U. S. firm in the business, The Permutit Company, designs and builds complete water-conditioning systems like that shown above for leading utilities and industrial power plants. Other Permutit installations are reducing costs or improving products for almost any industry you can name. For advice on any water conditioning problem, simple or complex, write: The Permutit Company, Dept. PR-3, 330 West 42nd St., New York 36, N. Y.

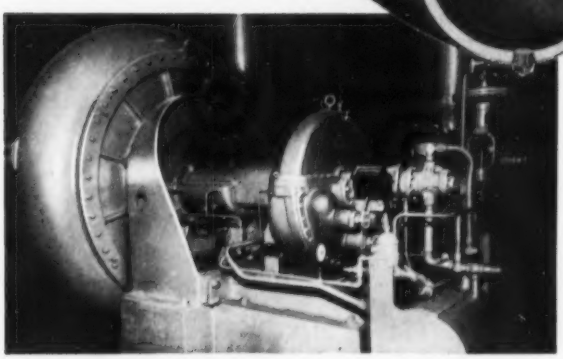
PERMUTIT®

rhymes with "compute it"

WATER CONDITIONING for BOILERS, PROCESSING, PUBLIC and HOME WATER SUPPLIES

Accent on rugged simplicity

CASING AND BACKPLATE of cast Meehanite. All surfaces adjacent to the impeller are machined to close tolerance.
ONE-PIECE, OPEN TYPE IMPELLER; develops no end thrust; mounted on tapered shaft and readily removable.
BASE AND HOUSING of heavy fabricated steel, strong and rigid.
INLET CONNECTION AND GUIDE VANES of cast Meehanite.



Typical installation of an Elliott compressor handling 25,000 inlet cfm of air, at a discharge pressure of about 2.5 psig; driven by Elliott 300-hp steam turbine at 3300 rpm.

P4-2

ELLIOTT

CENTRIFUGAL COMPRESSORS

are extremely simple in design and construction. Hundreds are serving in processes requiring the handling and compression of large quantities of air or gas. All parts in contact with the gas to be handled can be made of suitable materials.

Elliott compressors are made in both single-stage and multistage types, for pressures up to 1000 psig, with capacities to 175,000 cfm. Elliott Company also builds the motor or turbine drive, including speed-increasing gears when required.

For details and specifications consult your local Elliott field engineer, or write Elliott Company, Centrifugal Compressor Dept., Jeannette, Pa.

ELLIOTT Company

TURBINE-GENERATORS TURBINES MOTORS GENERATORS DEAERATING HEATERS EJECTORS CONDENSERS COMPRESSORS TURBOCHARGERS TUBE CLEANERS STRAINERS

For more data on advertised products, use Readers' Service Cards, last page.

Now...a New advance in...

Gauge Safety!

Another step ahead in Marsh Gauges: the new Marsh "Safecase". Down to the final detail this gauge is developed for those applications where an unexpected surge of heavy, explosive over-pressure can occur.

In the "Safecase" a solid metal barrier protects the entire face. But, still more important, the *entire back* of the gauge is a thin, ductile plate, designed to open out when subjected to abnormal pressure. Back plate is held firmly to the case by two holding screws and cannot be dislodged by a pressure blowout.

In exhaustive tests it has never been possible to shatter the crystal or create any other dangerous condition in a "Safecase" gauge with its safety-release back. The accompanying illustration shows the result of one of a series of tests in which blank cartridges were fired in the back of the case without even breaking the crystal. Think what that means in safety to operating men!

Yes, an important development . . . but merely the kind you would expect from the manufacturer who originated the "Connoweld" tube, the "Marshalloy" case, the Mastergauge movement and practically all of the major advancements in pressure gauges. Ask for up-to-the-minute information.

Pressure of explosive force merely opens out safety back

Instead of depending on blow-out plugs, entire back of Safecase Gauge is designed to yield to over-pressure. Photo at left shows actual result of firing cartridge within back of case. Safety-release back exhausted pressure. Front remained intact.

MARSH INSTRUMENT CO.
Sales affiliate of Jas! P. Marsh Corp.
Dept. R, Skokie, Ill.
HOUSTON BRANCH PLANT:
1121 Rothwell St., Sect. 15, Houston, Texas
Marsh Instrument & Valve Co. (Canada) Ltd.,
8407 103rd St., Edmonton, Alberta, Canada

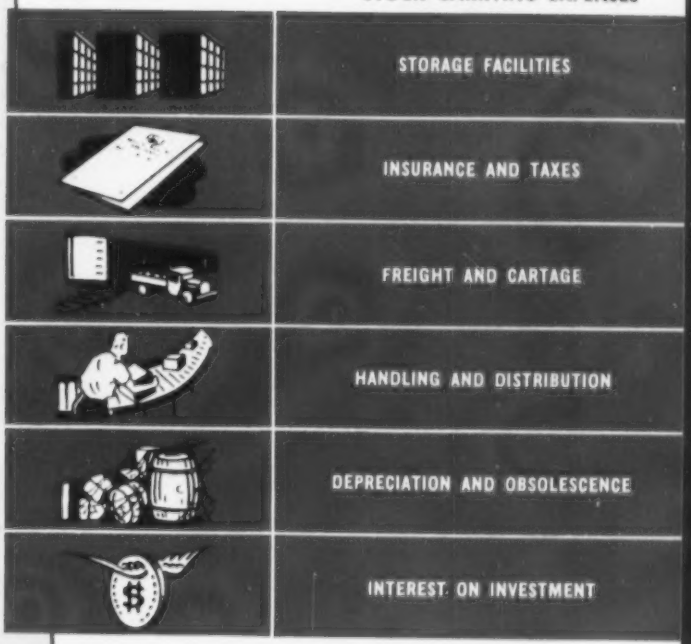
"THE STANDARD OF ACCURACY"

MARSH GAUGES

It Costs You A Minimum of $120.00* A YEAR to Stock $1000.00 WORTH of Industrial Supplies... YOUR JOBBER does it for You FREE

* Minimum cost determined from survey made by "Industrial Distribution."

STOCK CARRYING EXPENSES



Stock carrying costs are worth the careful consideration of every company in industry. The figures here are the findings of INDUSTRIAL DISTRIBUTION magazine from an analysis of plant cost studies. But this saving is only one of numerous advantages the industrial jobber offers you. Others are: time-saving in delivery, ordering convenience, technical assistance, etc.

Your MIDWEST Jobber Can Save You Money on Welding Fittings

In addition to the savings indicated above, the Midwest jobber offers you a substantial further saving in Midwest "Long Tangent" Elbows. These give you from 21% to 42% more elbow *for the same price* and permit better piping design. Ask our jobber for Catalog 54 to get all the facts.

7407

MIDWEST PIPING COMPANY, INC.
Main Office: 1450 South Second Street, St. Louis 4, Mo.
Plants: St. Louis, Passaic and Los Angeles

Sales Offices:
New York 7—50 Church St. • Chicago 3—79 West Monroe St.
Boston 27—426 First St. • Los Angeles 33—520 Anderson St.
Houston 2—1213 Capitol Ave. • Tulsa 3—224 Wright Bldg.
Cleveland 14—616 St. Clair Ave. • Miami 34—2103 Le Jeune Rd.
STOCKING DISTRIBUTORS IN PRINCIPAL CITIES

Cleats reduce slipping on football fields, but–

WALK and WORK SAFELY

on low-cost A.W. SUPER-DIAMOND

ECONOMY ROLLED STEEL FLOOR PLATE

Forty raised steel figures to the step are your assurance of foot safety. Secrets of SUPER-DIAMOND's anti-slip protection for men and rolling equipment are the diamond design and alternate spacing of figures at right angles and correct distances for maximum friction from any angle of approach. After years of usage, the diamond pattern still retains its safe, comfortable footing . . . still permits quick cleaning and draining.

Made from tough steel floor plate, SUPER-DIAMOND can be fabricated with normal shop equipment. There are no matching problems. Use it structurally, as an overlay or as a complete flooring.

No other floor plate can match A.W. SUPER-DIAMOND's *safety, durability and easy maintenance at so low a cost.*

A.W. SUPER-DIAMOND

ROLLED STEEL FLOOR PLATE

"The diamond in the rough . . . a gem of a flooring."

ALAN WOOD STEEL COMPANY

Conshohocken, Pa.

Please send A.W. SUPER-DIAMOND Booklet SD-8

Name_____

Title_____

Company_____

Address_____

City_____ Zone_____ State_____

Other products: A.W. ALGRIP Abrasive Rolled Steel Floor Plate—Plates—Sheets—Strip—(Alloy and Special Grades)

For plants where oil, water and grease raise special problems of slipping accidents, we suggest a check on the special qualities of A.W. ALGRIP . . . the world's only abrasive rolled steel flooring.

ALAN WOOD STEEL CO. A.W. 1826 CONSHOHOCKEN, PA.

The Mail Box . . .

Mist Citations

To The Editor:

In an article "Careful! Mists can explode" published in your November issue, it is stated that "although particle size is expected to be a factor in mist explosions, no quantitative data are available." The author has evidently overlooked our recent work on mist explosions and particularly a paper by Cohen and myself in the Proceedings of the Royal Society, London, 1954, A225, 375, entitled "The Effect of Drop Size on Flame Propagation in Liquid Aerosols." Other work on flammability limits of mists is reported in The Engineer, July, 1954, under the title "Explosion Characteristics of a Lubricating Oil Mist."

J. H. Burgoyne
Department of Chemical Engineering,
Imperial College of Science & Technology,
Prince Consort Road, London, S.W.7

Reply by Author

The data reported by Burgoyne and Cohen on the effect of particle size on flame propagation in mists show that droplets below 10 micron act in a flame as if they were completely vaporized. Beyond 10 microns the lower limit of flammability decreases with increased particle diameter. The flame velocity actually increases. Oil droplets formed by a vapor quench are about 10 micron or smaller. Thus, as reported in my November REFINER article, the lower limits of flammability for mists and vapor-air mixtures are identical.

J. Eichhorn
The Dow Chemical Company
Physical Research Laboratory
Midland, Mich.

We Fill the Bill

To the Editor:

Please send me two copies of the September, 1955 PETROLEUM REFINER 18th Annual Process Issue. I have enclosed a check in the amount of $2 in payment for same.

Glad to see you publish a 1955 edition for petrochemicals as you did in December, 1954. You are to be commended especially for these wonderful process issues. They are invaluable in keeping one informed of the changes and progress of petroleum technology and engineering.

Louis W. Brunn
Pittsburgh, Pa.

By Far the Best

To The Editor:

Please send me a copy of the Author's Handbook dealing with preparation of technical articles.

By the way your magazine is far and away the best in its field.

Robert C. Oliver
Long Beach 3, Calif.

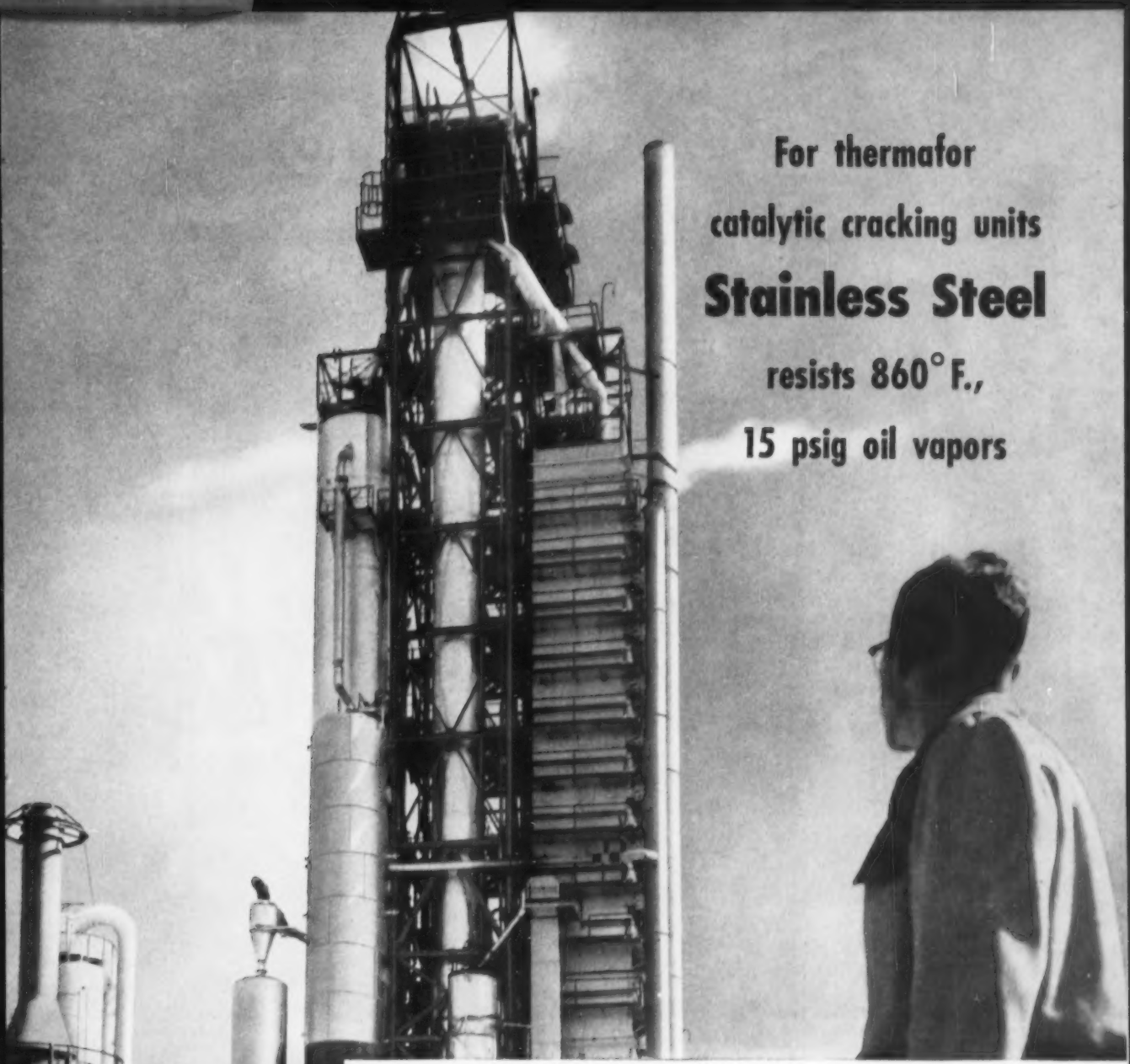
Likes 'Em Clip-able

To The Editor:

Congratulations on a spendid issue October, 1955, one of the best single issues of any journal I have received.

However please try to separate the articles so I can clip and file them without losing one.

John K. Jacobs
Philadelphia



For thermafor catalytic cracking units

Stainless Steel

resists 860° F., 15 psig oil vapors

How different refineries would be without Stainless Steel! And how much *more* they would cost to operate! Almost every time you find a high temperature, corrosive situation, you find lots of Stainless Steel.

In the unit shown here, the reactor chamber is lined with 7/64" type 410 Stainless. Reactor internals, bubble caps and trays and various vessel linings are also made from Stainless Steel. These are decisive steps to reduce the continuing high cost of refinery plant corrosion.

When *buying* Stainless Steel, remember that United States Steel offers the widest range of sizes, grades and types. Selection is easy, and you can be sure of service-tested USS quality.

El Dorado, Arkansas refinery of Lion Oil Company, a division of Monsanto Chemical Company.

SEE The United States Steel Hour. It's a full-hour TV program presented every other week by United States Steel. Consult your local newspaper for time and station.

UNITED STATES STEEL CORPORATION, PITTSBURGH · AMERICAN STEEL & WIRE DIVISION, CLEVELAND
COLUMBIA-GENEVA STEEL DIVISION, SAN FRANCISCO · NATIONAL TUBE DIVISION, PITTSBURGH
TENNESSEE COAL & IRON DIVISION, FAIRFIELD, ALA.
UNITED STATES STEEL SUPPLY DIVISION, WAREHOUSE DISTRIBUTORS
UNITED STATES STEEL EXPORT COMPANY, NEW YORK

USS STAINLESS STEEL

SHEETS · STRIP · PLATES · BARS · BILLETS — USS — PIPE · TUBES · WIRE · SPECIAL SECTIONS

6-805

UNITED STATES STEEL

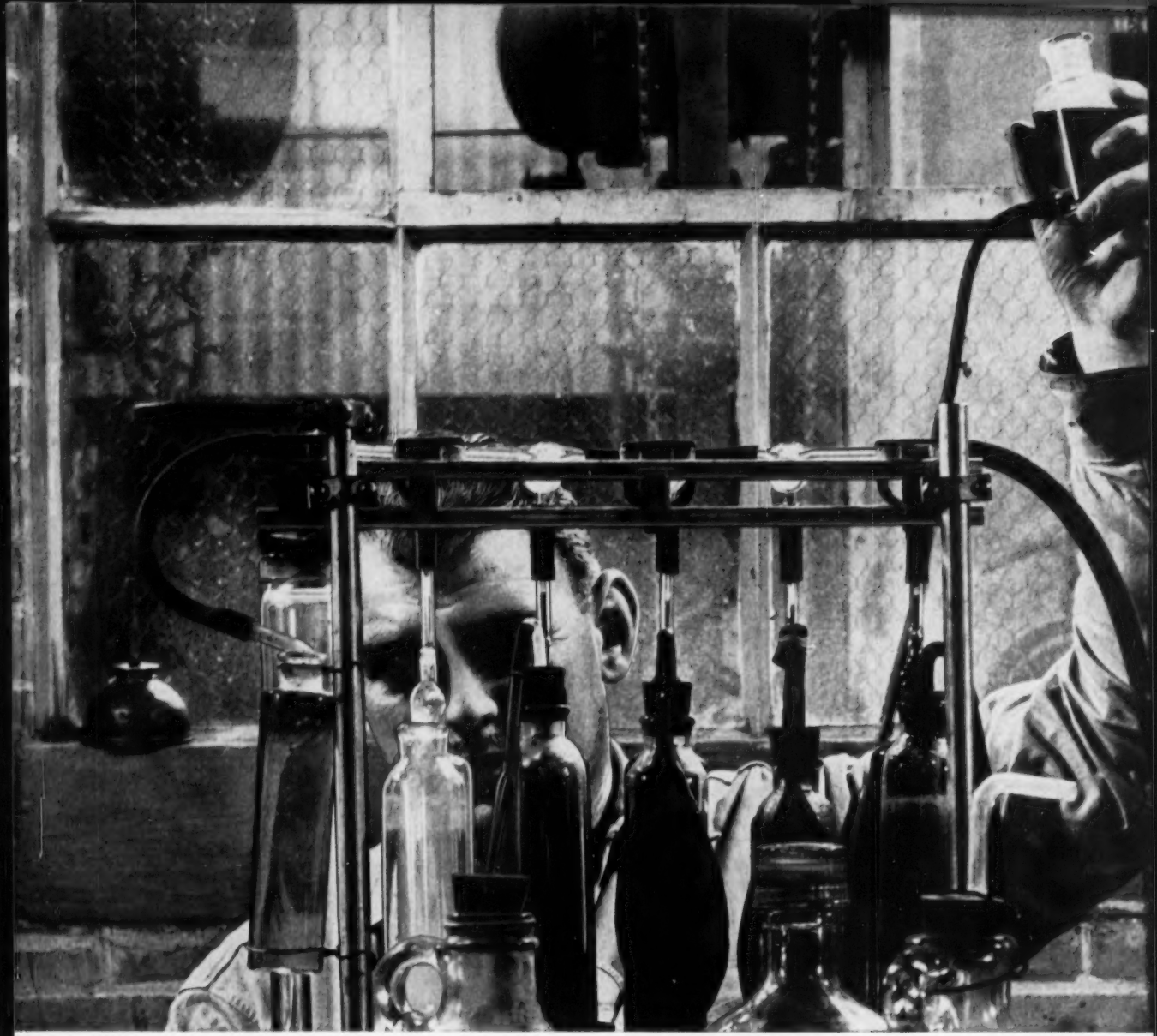


Photo courtesy Standard Oil Co., IN. J.

boost average ratings as much as 2 octane numbers *with the LJUNGSTROM® AIR PREHEATER*

With waste heat recovered and returned to the furnace in combustion air, the most modern heat-transfer systems can be operated at peak efficiency.

That's why you boost product quality with the Ljungstrom Air Preheater. Its heat-recovery efficiency makes possible advanced furnace designs that assure remarkably close control of processing. And finer control means a more uniform product . . . with average ratings as much as 2 octane numbers higher. One still's added income just from higher product quality is $58,000 annually.

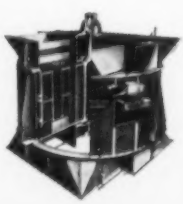
How fast is "WRITE-OFF"?

In earnings from higher octane ratings, many refiners write off the cost of the Ljungstrom installation in less than two years. This time is cut to nine months and even less, when the other Ljungstrom advantages are taken into account – saves up to 20% in fuel costs . . . permits more economical furnace design, with no need for convection surfaces . . . burns many fuels you used to throw away . . . results in consistently higher through-put . . . and minimizes slag.

For more complete details on what the Ljungstrom Air Preheater can do for you . . . for an analysis of the heat recovery benefits obtainable in fuel burning equipment – call or write The Air Preheater Corporation.

Wherever You Burn Fuel, You Need Ljungstrom

The Ljundstrom operates on the continuous regenerative counterflow principle. The heat transfer surfaces in the rotor act as heat accumulators. As the rotor revolves, the heat is transferred from the waste gases to the incoming cold air.



The Air Preheater Corporation 60 East 42nd Street, New York 17, N. Y.

A Quick Look at the Industry THIS MONTH

Petroleum REFINER
March, 1956

All industry outlook: Business is booming despite slowdown in auto production and home building. Prediction: Economists will reverse previous forecast for business to drop off last half of year. They will soon predict trend to continue upward—possibly into '57.

Refiners to Have Good Year . . .

Refining outlook: Bright—with reservations. Demand to continue upward averaging 9.3 million barrels daily for next 3 months—5 percent over '55. Watch out for inventories: Gasoline stocks are 5.2 percent higher than previous estimates. Kerosine and distillate stocks are 9 percent below. Unbalanced stock situation may cause trouble if refinery yields aren't adjusted.

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Wages to Jump in '56 . . .

The wage picture: '56 wage increases will show decided jump over '55. Esso Standard, Humble, Gulf and Magnolia have offered—with union acceptance in most cases—a 6 percent minimum increase. Result: 15 cents an hour boost in '56 compared with 10 cents last year. Look for other oil companies—union and otherwise—to follow suit.

-•-

Boost in Crude Prices? . . .

With increased demand—higher wages—mounting costs breathing down their backs, oil leaders are taking a long look at possible boost in crude prices. Perhaps before '57. Crude prices have been hiked only once (25 cents) since '47.

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Octanes Show Increase . . .

Postings on octane race: Latest octane survey shows U. S. average for premium was 96.4 octane in February—up 1.6 from year ago. Regular: 89.2—up 1.8. Jackson, Miss., was premium leader with 97.6. Baltimore, Md., took blue ribbon for regular with 91.4.

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Tips for Refiners . . .

Latest developments: Cosden-planned styrene plant has new wrinkle—ethyl benzene is recovered from mixed xylene streams instead of reacting ethylene and benzene as in conventional schemes. Ethyl benzene will be separated by ultra fractionation—will require 200-foot towers.

Petrochemical researchers have come up with new tongue twister—polypropylene. It's made from propylene, of course. Advantage: Much higher melting point than polyethylene—offers new commercial potential for propane and propylene. Disadvantage: Subject to aging and cracking.

Nylon fiber paper is on the way. Advantage: High tear strength. Resists attack by chemicals, bacteria, molds, light and moisture.

New fire fighting method circulates cooler liquid from bottom of tank to quench flames on surface. Extinguished fire in 8000-gallon coal tar tank within 30 seconds.

-•-

How to Beat the Engineer Shortage . . .

Want to beat the engineer shortage? Increase technician-to-engineer ratio, say the experts. One industry leader says proper ratio is 2 to 1. Survey of 18 oil and chemical firms showed average of only 0.9 technicians for each engineer.

A Quick Look at the Industry (continued)

Jet Fuel Demand to Shoot Upward . . .

Jet fuel consumption will continue meteoric rise in '56 to 73 million barrels. This is 15 million barrels more than '55 and 27 million more than '54.

TWA's order for 8 jet liners by '59 completes "big four" air carrier lineup. Cost: $4.5 million each.

Some economists say airlines bought too many jets. Airlines belittle reports, point to traffic experts who predict U. S. will need nearly double present seat capacity by '62.

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Harris Bill Veto Brings Strong Reaction . . .

Washington scene: President Eisenhower says oil industry reactions were not generally bitter toward Harris Bill veto. Industry actions tell a different story: Drilling programs and sales to interstate pipelines are being held back in increasing numbers—at least until FPC decides how it will handle controls.

-•-

The Labor Picture . . .

AFL-CIO is ready to roll in all-out organizing campaign. Potential in crude oil and natural gas: 205,000 unorganized employes out of 305,000 total.

Sparks are flying from friction between AFL-CIO and independent oil unions. Say the "Indys"—if you try to move in on us, we'll see what can be done about taking over some of your weak AFL-CIO oil locals.

Efforts to strengthen independent forces picked up last month. Fourteen Humble unions set the stage for merger involving 16,000 employes.

-•-

New Marketing Idea Shows Promise . . .

New horizons: Service station-blended gasoline to meet each motorist's needs is being pioneered by 17 Sun stations at Orlando, Fla. Using new type pump that offers 5 grades of gasoline (top quality is 100-plus octane)—Sun might be starting a revolutionary new marketing ball rolling merrily on its way. Effect on refiners: If idea succeeds, part of gasoline blending process would switch to service stations.

Coal Burning Gas Turbine by '57 . . .

Coal is making bid to re-enter railroad fuel picture. First coal-burning gas turbine engine will be built in '57. Probable first user: Union Pacific. In '43 railroads were coal's biggest market, using 23 percent of all production. Now, with railroads more than 85 percent diesel, they use less than 1 percent.

Air Pollution Laws Getting Tighter . . .

Courts are cracking down on air pollution law violators. Court cases totaled 2974 in '55 compared with 395 the previous year. Fines jumped from $22,575 in '54 to $139,235 last year. Conviction percentage rose from 87.5 percent to 92.3.

New Oil Fields Show Promise . . .

Seventy-three new oil fields rewarded U. S. wildcatting during January, and as usual the majority were of minor importance. However, some show promise, and five of those were: Shamrock Oil & Gas' Ochiltree County, Texas Panhandle, discovery good for 562 barrels of 38-gravity oil daily; Provincial Oil's find making 528 barrels of 50-gravity in Grant County, Oklahoma; Sunray Mid-Continental's Lea County, New Mexico, oiler potentialed for 341 barrels of 46-gravity; Felmont Oil's Dawson County West Texas, discoverer of 308 barrels of 36-gravity; and Midwest Oil's strike in Borden County, West Texas, good for 237 barrels of 40-gravity oil a day.

Ed— This is something for every oilman to think about!
G.H.

PUBLISHER'S PAGE

Whose Job Is It?

Whose job is it to see that the oil business has a better understanding at the hands of the public? Is it just the job of the American Petroleum Institute and its committees? Is it just the job of the company executive who may be a heavy stockholder—or who may not be but who has an interest in keeping a good job?

No, the responsibility goes far deeper than that. It goes to *every* individual who works in the oil business whether he works out in the oil fields, in a refinery, on a pipe line or works at a pump in a filling station.

If he intends to stay in the oil business then he had better do everything he can to help the oil industry get and maintain a good name at the hands of the public. His job is likely to be just about as stable as is the reputation of his industry

How can you or anyone employed in the oil industry help it to secure and maintain a good name?

The answer to that is easy:

- So conduct yourself in all of your operations as an oil man in contact with the public so that the public will feel "that's a good oil company to do business with."
- If you hear somebody making a statement about the oil industry which your own information tells you is untrue, correct it in a friendly manner.

It is just as simple as that. If the several million employes of the oil industry in the U. S. will do just these two things, the results will be far greater than could be expected from a multi-million dollar advertising campaign.

And just as an editorial writer in one of our publications said last month, "this is not a job for just a week in the year —it is an every-day job, 365 (leap year 366) days in the year."

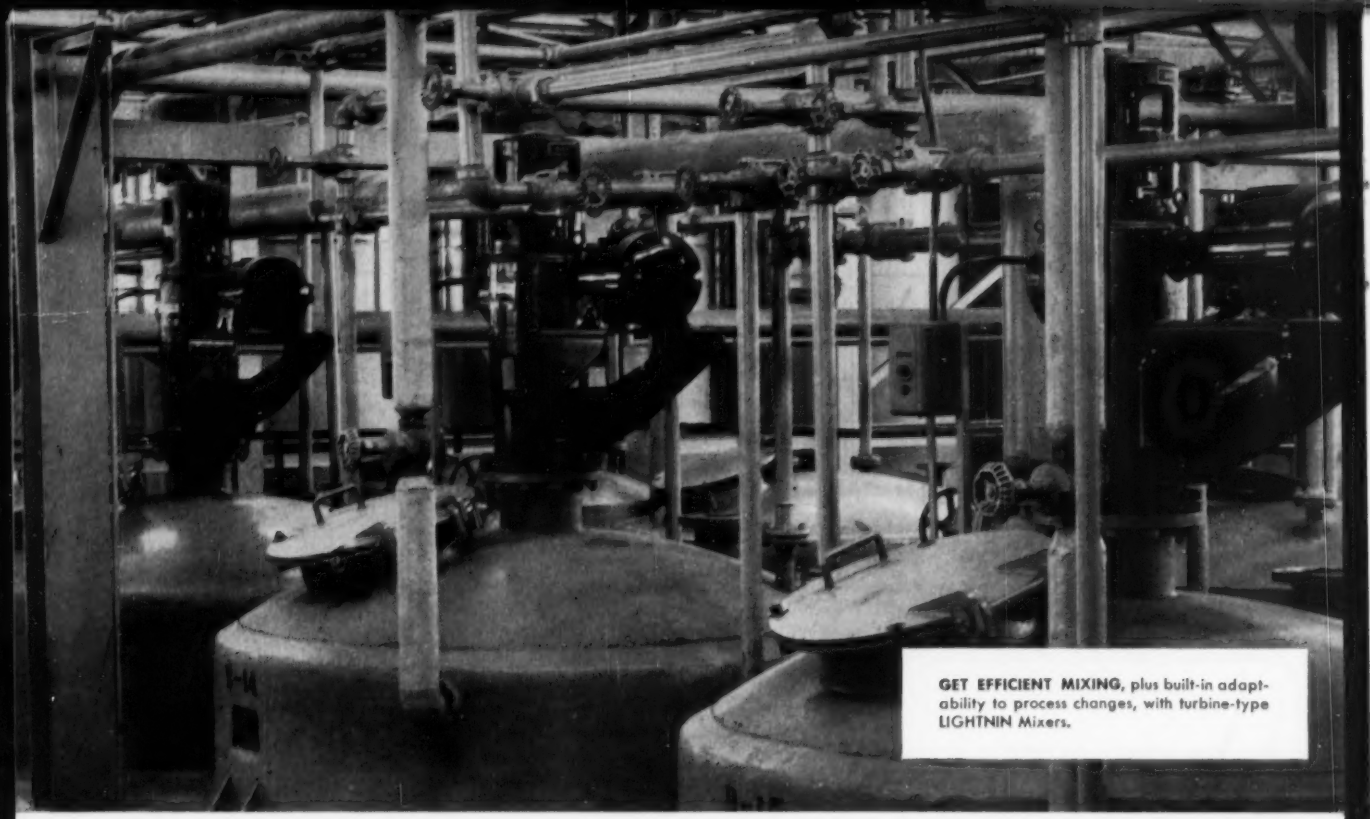
Ray L. Dudley

Current Outlook Section • 43

This editorial, of vital importance to all oil men and women, appeared in the January, 1956 issue of WORLD OIL and is presented for your information by the

AMERICAN PETROLEUM INSTITUTE
50 West 50th Street, New York 20, New York

For more data on advertised products, use Readers' Service Cards, last page.



GET EFFICIENT MIXING, plus built-in adaptability to process changes, with turbine-type LIGHTNIN Mixers.

Use this **proved method** *to get good fluid mixing*

You can't afford to *guess* about fluid mixing. And you don't need to.

On any mixing operation you can get factual answers to questions like these, to guide you in your mixer selection:

1. What precise balance of *fluid flow* and *fluid shear* will do my mixing job best?
2. If this balance can be attained in different ways, what is the *most efficient* and economical way?
3. In scaling-up, does power required per unit volume remain constant? If not, by what factor does it increase or decrease?
4. Will the mixer transmit the required power to the mix, and do it efficiently?
5. Can the mixer be installed without special construction? Can I get standard replacement parts quickly if I ever need them?
6. Am I protected against mixer obsolescence in case of a process change?

You *know* the answers to these vital questions, when you mix with LIGHTNIN Mixers.

Predicting results

Even on the simplest mixer application, your LIGHTNIN sales engineer's recommendation is based on thousands of pilot runs, plus years of in-the-field experience.

On complex mixing jobs, pilot runs at MIXCO quickly find the impeller-to-tank diameter ratio and input power that will produce the optimum fluid regime most economically. Scale-up is *guaranteed accurate.*

Mechanical economy

Your mixer investment goes into equipment that is mechanically up-to-the-minute. Hundreds of *standard* LIGHTNIN power-speed combinations (interchangeable in many models); widest possible choice of in-stock materials and interchangeable components, give you assurance of correct application, smooth running, and flexibility when you need it.

For fluid mixing that does what you want it to do, call in your LIGHTNIN Mixer representative. (He's listed in Refinery Catalog.) Or write us direct.

GET LOWEST-COST MIXING, gasoline blending, suspension of BS&W in crude, with LIGHTNIN Side Entering Mixers. New rotary mechanical shaft seal ends stuffing-box repacking forever; stops leakage; runs for years without adjustment. Yet you can replace it in minutes if ever necessary.

"Lightnin® Mixers"

MIXCO fluid mixing specialists

FOR LATEST MIXING INFORMATION and full description of LIGHTNIN Mixers, send for these helpful bulletins:

- ☐ B-102 Top or bottom entering; turbine, paddle, and propeller types; 1 to 500 HP
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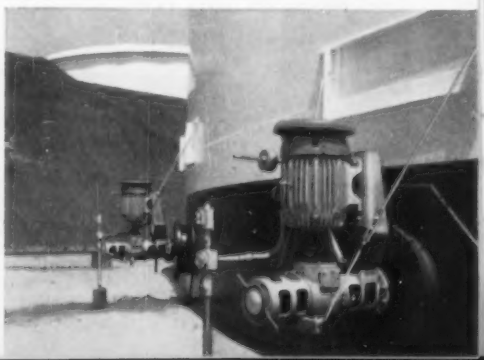

***Public sentiment is everything. With public sentiment nothing can fail. Without it, nothing can succeed.*—Abraham Lincoln**

Actions Speak Louder than Publicity

VETO OF THE HARRIS BILL—the events preceding it—and the wording of the veto have rocked oil industry public relations back on its heels. According to the Philadelphia Inquirer-Sun, "Public opinion toward the oil industry was set back 10 years by the gas bill."

Why is it that one of the nation's greatest, most stable industries was turned "thumbs down" on a bill of such economic importance—a bill the President said he favored? Was it because of a single political contribution?

This is hard, in fact, well nigh impossible to believe. *If an industry has won the understanding and good will of America's millions no single act can tear it down in one fell swoop.*

Therefore, there is only one conclusion to make: The oil industry still has a long way to go before it can list the public as an ally. This statement is made despite the fact that the Oil Industry Information Committee has done yeoman work since its beginning 10 years ago. And despite the fact that oil companies have increased their own public relations efforts manyfold during the same period.

Various reasons are given for the industry's lack of progress in winning public favor. The OIIC catches some of the brunt. Others stick to the old cliche that the American public has—and always will have—a general distrust of big business.

However, the problem goes much deeper than that. For one thing, it concerns the interpretation of the term "public relations." Too many oil men sincerely believe that public relations means public(ity) relations. If this were true, the OIIC would have solved the public attitude problem long ago.

Last year alone, 30,000 OICC volunteers told the story of oil to nearly 10 million people through motion pictures—distributed several million pieces of educational material to 7320 schools—and personally contacted 67 percent of the nation's newspapers, and radio and television stations.

These are efforts of which any industry would be proud—and they have been picking up momentum since 1946. Now, let's look at OIIC's most recent public opinion survey:

- Twenty-three percent of the American public thinks the oil industry makes too much profit. Although this is the lowest percentage of the past five surveys, it is still two percentage points higher than the first tabulation in 1946.
- When asked if they favored government regulation of the oil industry, 12 percent of the people queried said "yes," the same as in 1950.
- Although there were no majority criticisms of the industry in 1955, the most negative opinions were that the industry is not fully competitive, is controlled by a few companies, and charges prices that are too high.

It is important to note that the OIIC survey was completed before President Eisenhower killed the Harris Bill. Only the future will tell what his signature did to public opinion.

The truth is that a good share of the U. S. public thinks the oil industry is not as good a citizen as the industry credits itself with being. And public opinion, believe it or not, had more to do with the defeat of the Harris Bill than a political contribution or the President's veto.

There were many good points in the 1955 public opinion survey compared with previous years, it's true. And there were many improvements. But, the facts mentioned here are significant. They clearly illustrate that publicity can not create public favor on its own merits.

The oil industry must face these truths if it is to progress in its relations with the public. And progress it must, for the public more than any one single factor will determine the industry's future.

How can the oil industry improve itself in the eyes of the public?

It is patent that the OIIC and company public relations departments by themselves can not shoulder the responsibility. They must be aided by proper actions and good judgment by top management of the industry.

Before real progress can be made, the industry must stop its internal bickering. This business of producers fighting publicly among themselves about imports—refiners and producers squabbling about prices paid for crude oil—jobbers against refiners and integrated companies—gas distributors working against the Harris Bill—are certain to impede public relations progress.

Each bickering segment of the industry seems determined to confirm at least part of the worst statements blasted forth by its enemies.

The negative impact of internal back biting was aptly described by Shell President H. M. S. Burns: "The Department of Justice gets more complaints against one or the other segment of the oil industry than it does in respect to all other industries put together. And I'll be willing to bet that nearly every complaint comes from within the industry itself.

"All of this keeps things stirred up in a sea of ferment and makes our great industry look like an aggregation

REFINER'S GUIDE—for using Du Pont Metal Deactivator

APPLICATIONS	BENEFITS
Motor Gasoline	Protects your high octane gasoline by preventing copper-caused gum, often a source of customer dissatisfaction. Du Pont Metal Deactivator may also provide important savings when used with other Du Pont additives.
Kerosines	DMD is useful as a color stabilizer in some copper-sweetened stocks. It has also been reported effective in reducing carbon and coke formation in pot burners by as much as 50%.
Jet Fuels	DMD has been approved by military specification (MIL-F-5624C) for use in jet fuels to inhibit deterioration, thereby decreasing fuel system plugging and residue formation.
Diesel Oils, Home Heating Oils	DMD helps prevent color deterioration, improves storage stability, inhibits formation of gelatinous sludge due to copper pickup.
Turbine Oils	The advantages vary according to service.
Greases	Displays benefits in greases for bearings which may have copper content. It is frequently used in conjunction with a Du Pont antioxidant.
Special Applications	DMD counteracts the catalytic effect of metals on gasolines during long storage periods, and this is especially important for stabilizing "driveaway" gasolines.

If you use, or have need for, metal deactivator, why not make use of Du Pont Technical Services?

Are you benefiting from the advantages of using metal deactivator in all possible applications?

Are you getting the *most* product improvement from the metal deactivator you are now using?

Can you get improved benefits at lower cost with combinations of Du Pont Metal Deactivator plus other special-purpose additives?

No one can give you snap answers to these and other important questions regarding the prevention of metal catalyzed gum formation. But you can get accurate information easily from the Du Pont regional laboratories. There are five in all and one is conveniently near you.

The service representatives at these Du Pont laboratories will be glad to work with your staff on your own particular products and problems. Because combinations of DMD with other Du Pont additives so often bring greatly increased benefits, Du Pont technical people are especially well-equipped to help you. They may, for example, be able to show you how a combination of different additives can cut the total additive content you need . . . possibly give added effectiveness, at less cost.

To explore these interesting possibilities, contact your Du Pont Petroleum Chemicals Division representative. He'll be glad to work out a program of technical assistance to fit your individual needs. Just call him at one of the sales offices listed below.

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of brawling school kids who deserve to be slapped down and regimented by Uncle . . . Sam."

In simple language, the oil industry must seek to settle its differences within industry circles rather than in a public arena. Otherwise adverse public opinion results.

The recent Harris Bill debacle proved that ill wishers can do enough harm to the oil industry—without the help of internal strife. During the heat of the debate some of the nation's most influential newspapers took up the cudgel against wealthy oil interests "buying" their way free of government control. No mention was made of the investments made by the opposition. Why? Because the oil industry is big. It is vulnerable. And thus it makes a prime target for those who differ with its policies—or those who would like to see the industry weakened. All of the prior efforts of the OIIC and other public relations groups combined had no influence whatsoever on these newspapers.

The oil industry must face the reality that stories such as these (and others we shall discuss in future issues)—even if not true—are successfully nullifying its efforts to create public understanding and good will.

Oil's public relations problem will never be solved until each and every one of the two million people who work in the industry becomes a spokesman in its behalf. Every person who gains his livelihood from oil is obligated to know his industry—and to stand up for it when needs be. He must work every day of the year to give his company a good name. He must be ready to defend his industry when it is unfairly attacked. This one common sense fact can and *must* be hammered home from every direction—from every level in the industry.

But, most important of all, the industry must first *deserve* the good things that are said about it. Before this can be accomplished, oil men must start evaluating their public relations efforts in terms other than column inches or total hours on radio and television.

The new terms: *Action*—action that merits the understanding and good will of the public. Then, good public relations will come naturally—and it will be deserved. Strange as it may seem to some, the American public forms its opinion from what the oil industry *does*—not from what it *says*.

Actions speak louder than publicity.

Building Boom Still On

NEW CONSTRUCTION in the U. S. A. is still booming. A check of the PETROLEUM REFINER's January boxscore shows that the expansion is about equally divided between (a) refining activity, (b) new refining capacity and (c) petrochemical plants. The actual breakdown was—

Refining expansion, etc.	**$328 million**
New refining capacity	**325 million**
Petrochemicals	**343 million**

As was expected petrochemicals lead the field.

Total figures for expansion going on outside the U. S. A. came to $1506 million. This with the $996 million for the U. S. A. gives a world total of $2502 million.

Notice that the U. S. A. is only about $500 million behind the entire world and is still doing about 40 percent of the worldwide expansion in refining and petrochemicals.

The worldwide 1506 million breaks down thus:

Refining expansion, etc.	**$215 million**
New refining capacity	**855 million**
Petrochemicals	**436 million**

Many industry people had expected to see new refining capacity amount to more than refining activity and petrochemicals. But they hardly expected that petrochemicals would run more than 25 percent of the total expansion activity.

There figures would indicate that U. S. A. refiners are more interested in firming-up and adding new units than their foreign counterparts. Refining activity in the U. S. A. is about 50 percent more than the rest of the world.

Overseas expansion in new refining capacity is more than 2½ times that of the U. S. A.

Petrochemical foreign operations lead the state side activity by about $100 million.

This entire picture certainly indicates good demand for the products of refining and petrochemical plants.

In arriving at these numbers, some of the blank spaces in the boxscore had to be filled in. Too, all type of announcements were lumped together. Only those projects under construction, planned or projected were included in the tabulation. Plants completed in 1955 were omitted.

As to the terms used in the three classifications: Refining expansion is addition of new units and expansion of existing units in operating plants. New refining capacity is brand new crude processing and refining capacity never before in existence. Petrochemicals include all activity in the field of ammonia, synthetic fibers, plastics and hydrocarbon-based chemicals.

Activity Needs Slackening

CURRENT HIGH refinery activity is resulting in record product volumes. Until now there has been no serious consequences because demand for oils has also been at peak levels for the past three months. However, the industry's lowest demand period of the year is about to get underway. Need for oil products will start to decline during March and continue to ease during April and May. Unless production is geared to this slackening of demand, inventories will lose the favorable balance now existing.

Refinery runs reached a new all-time peak during the week ended February 24, averaging 8,084,000 barrels daily. Thus far, February's operations have averaged 8,034,000 barrels a day, compared with January's record 8,003,000 daily runs. One of the results of vigorous operations was the climb of gasoline stocks to new high ground. On February 24, gasoline in storage totaled 193,988,000 barrels, which was 12¾ million barrels more than was in tanks a year ago. A month earlier, these stocks had been only 9⅓ million greater than year-before level.

The latest tabulation of motor fuel stocks indicated that they had grown by 4½ million barrels in the short span of a week.

What Will Labor Union Merger Mean?

We were sorry to see the merger of the CIO and the AFL—sorry because we foresee ahead some serious trouble for our country as a result of this merger.

In the past, although occasionally some of its individual unions have been chock-full of racketeering and corruption on the part of union leaders, the AFL, generally speaking, has held a good reputation and has been a strong proponent of individual enterprise.

On the other hand, the CIO is nothing more or less than a front for Socialism as its platform has shown on more than one occasion. It has been our observation that every time the CIO has organized the plant of some acquaintance or friend, that organization was immediately followed by trouble. We know of instances where companies have deliberately refrained from the purchase of certain types of machinery because it was customary to have that type of machinery operated by a CIO operator—and a CIO operator meant trouble.

•

One of our strongest reasons for our opposition to the merger and our fear of its consequences lies in the single word "monopoly." We believe that our laws against monopoly in business are sound and are necessary. But we believe too that they should be extended to include unions as well.

A union officer has no more right to engage in a conspiracy against trade than does an industrial concern executive.

In the past the AFL has afforded some slight brake on the CIO in that the CIO appreciated at least the AFL segment of public opinion. If the two are joined together we fear that this braking action may be lost.

We are afraid that we may see all over the U. S. the occurrence of the shameful episode that has been occurring in the Kohler plant in Wisconsin. A more dastardly effort to destroy private enterprise has never been invented than that used in the Kohler plant by the CIO.

•

We have been an employer of union labor (International Typographical Union, affiliated with AFL) and have gotten along well with our union employes.

If a quick split doesn't arise between the AFL and the CIO elements of the new union, AFL men may well expect to see the militant, pushing CIO leaders take over. And that is a prediction. Whether they will be powerful enough to turn the country into Socialism is another thing—but the threat is there.

Ray L. Dudley

Publisher, PETROLEUM REFINER

TYPE 8-B

at RICHFIELD'S NEW WATSON REFINERY

Here, at the largest and most modern refinery on the West Coast, you'll find a complete line of "John Crane" Seals. Specifically designed for refinery service, these seals were selected for their ability to handle difficult liquids.

For instance, you'll find Type 8-B Seals handling propane at 100°F., 700 psi., spg. 0.475 . . . Type 1-B Seals on 4-stage pumps handling liquids at 190°F., 500 psi . . . Type 2 Seals in ethane-butane service at 90°F., 235 psi . . . others handling gasoline at 110°F., 445 to 460 psi.

These seals, in combination with the "John Crane" Type 9 Seal (incorporating sealing member of DuPont Teflon), are used in refineries everywhere.

The "John Crane" Type 9 Seal is especially adapted to handling light hydrocarbons and similar services where rubber sealing members cannot be used because of high temperatures and corrosive action.

Refinery engineers should have our new and latest literature on "John Crane" Seals.

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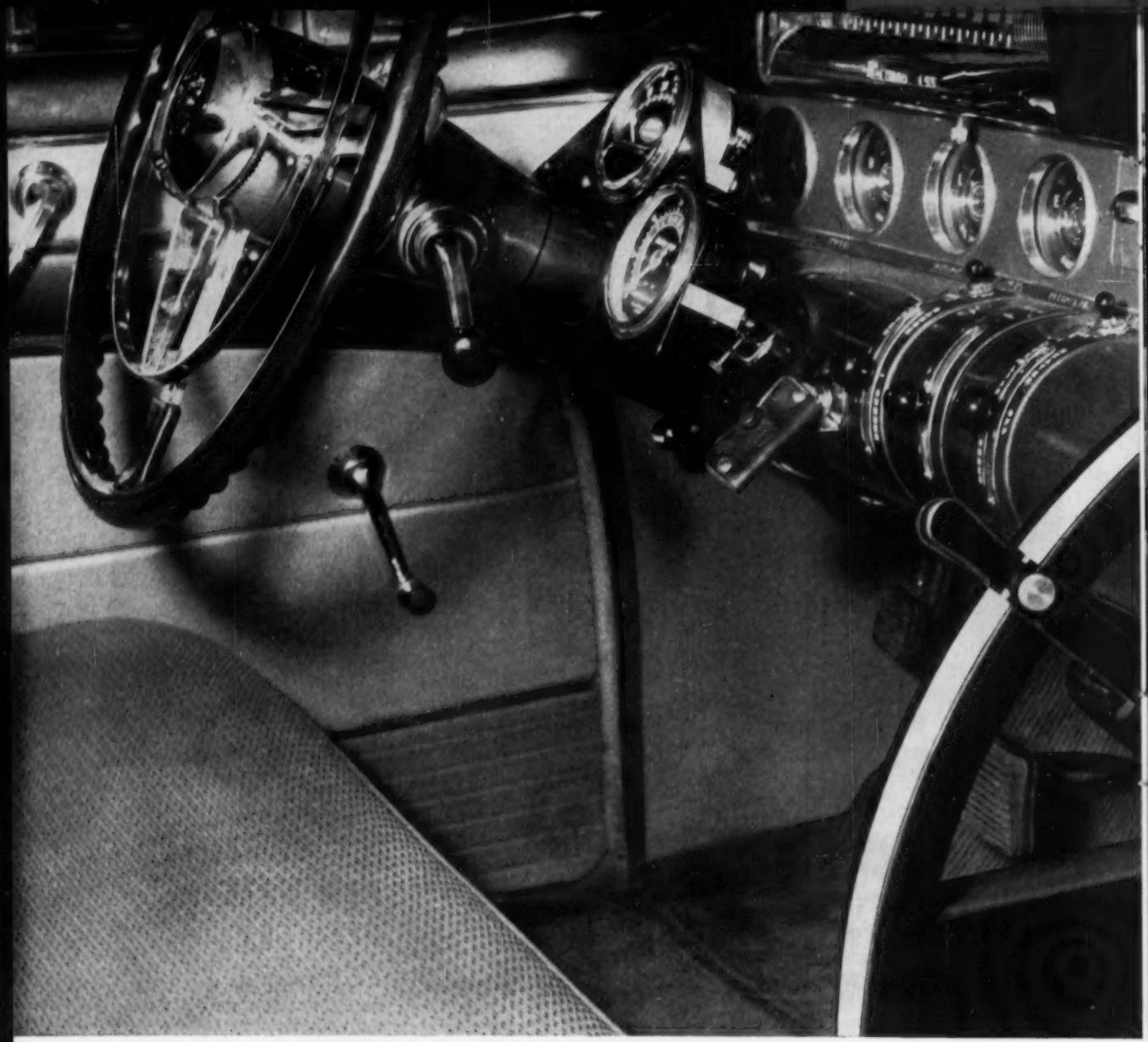

Above, test car with minimum instrumentation needed for fuel rating.

How Ethyl Research equips a car for accurate fuel ratings

Ethyl Research has for years been active in developing more accurate and economical ways of obtaining fuel ratings on the road—offering refiners convenient methods for evaluating their gasoline stocks.

At Ethyl Laboratories, we have found that the various road rating procedures can be adequately handled by a grouping of just five instruments, some of which can be seen in the picture above. But we have discovered that the addition of other key equipment (see right-hand page) can facilitate your road testing operations.

Our people have accumulated hundreds of thousands of miles of road testing experience with this equipment. If you would like more

(Advertisement)

Right, equipment suggested for more complete test-car setup.

information about this subject, please contact your Ethyl technical representative.

INSTRUMENTS SHOWN in this advertisement have proved satisfactory in Ethyl test cars but are not necessarily endorsed by Ethyl Corporation. Although the products of some specific manufacturers are shown, several of the instruments are made by various companies, and we'd be glad to mail you a list of sources. Just send your request to Box 14, Ethyl Corporation, 100 Park Avenue, New York, N.Y.

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Electronic spark protractor provides an accurate method for continuous indication of spark advance. It gives direct readings at all speeds.

Timing light (above), calibrated flywheel and sight tube are used for obtaining instantaneous spark advance position. Flywheel is marked in crankshaft degrees.

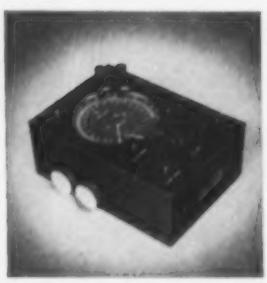
Auxiliary fuel system facilitates testing of several fuels in succession. Simple coupling connects the auxiliary line to the inlet side of the fuel pump.

Tachometers are accurate mechanisms for measuring the engine speed. They are adaptable for operation with any six- or twelve-volt system.

Vacuum gauge is required for part-throttle ratings. At any given car speed, the vacuum gauge permits reproducing part-load conditions.

Selector switches for thermocouples and resistance bulb thermometers are needed to permit reading temperatures at various locations.

Thermocouples and resistance bulbs are used to measure the temperatures of the coolant, the lubricating oil, and the air entering the carburetor.



Potentiometer is used to indicate the temperatures measured by the thermocouples. Road ratings require a rugged instrument, insensitive to vibration.

Ways to solve the problems of . . .

Employing the College Graduate

Interviewers and placement officials speak out on how oil companies and colleges can work together to expedite employment and increase applicants.

THE ANNUAL "student rush" is on. From February to April hundreds of oil company interviewers have visited—and will visit—college campuses across the nation. Each interviewer has but one objective: Fill those job vacancies—and fill them with top calibre men.

In 1956 it will be harder than ever to find top calibre personnel. There will be approximately 26,000 engineering and science graduates to fill an industry need for over 40,000. To say that competition will be keen is putting it mildly.

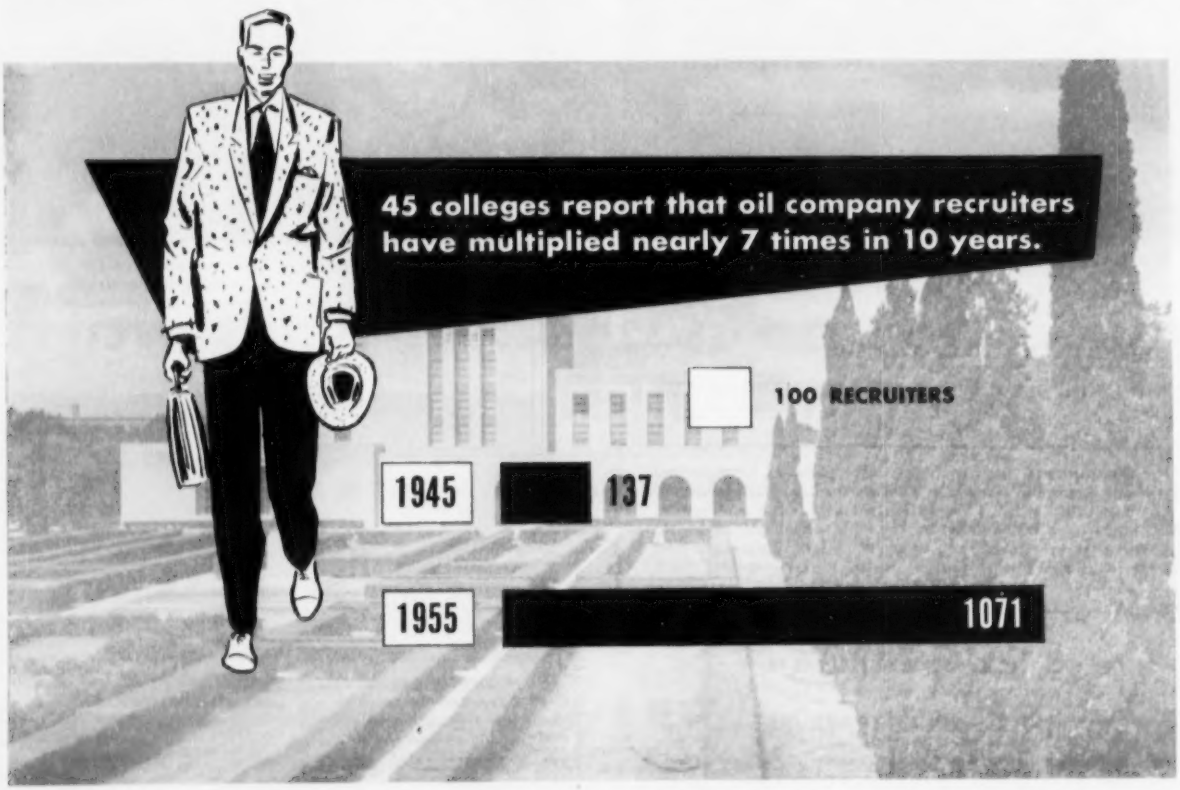
There has been a phenomenal growth in industrial recruiting of college graduates in recent years. It has become big business.

With the need and supply at such odds, no crystal ball is needed to see why industry is stampeding to the campuses. Last year, one group of 15 oil companies hired 1725 graduates through student interviews, compared with 386 in 1945. Out of 35 oil companies queried, 23 or nearly two-thirds have been using the college interview method of hiring for 10 years or less. Seven have been interviewing for less than five years.

The oil industry is but one of many that have jumped on the college interview bandwagon—and there are more to come. In fact, the trend toward college interviews has increased at such a phenomenal rate it has produced countless problems for interviewers and placement officials alike.

The following report is the result of a comprehensive survey conducted by PETROLEUM REFINER to determine what the major college interviewing problems are—and ways to solve them. It is intended to provide information and ideas that will benefit both the interviewer and the college placement director.

This is what 45 colleges and 35 oil companies have to say about modern day college interviewing practices.



20 suggestions from placement directors to interviewers . . .

1. Well in advance of campus visit, provide the College Placement Bureau with definite information concerning: (a) Plans for visit and time of arrival. (b) Campus schedule. (c) Number and type of graduates wanted. (d) Complete description of job openings, including type of work, location, salary and advancement possibilities. (e) Plans for faculty conferences. (f) Number and names of representatives who will visit the campus. (g) Handling of application forms in advance of arrival. (These points were mentioned by 26 of the 45 colleges replying.)

2. Make all arrangements for campus visits at least one month in advance. Some colleges requested three to six months notice. (21 mentions.)

3. Notify student promptly on decision. Send duplicates of correspondence to the Placement Bureau. (21 mentions.)

4. Provide well qualified interviewers who: (a) Know and like their work. (b) Have full understanding of college-age people. (c) Are well informed about job openings. (d) Are familiar with all phases of their company's operations. (e) Know how to conduct interviews. (17 mentions.)

5. At least two weeks in advance of visit, send factual company literature and brochures in quantities that meet the situation. Not so numerous or voluminous as to require an excessive amount of space for display, and reading time on the part of the student. (12 mentions.)

6. Organize program with one central office for entire company and subsidiaries, rather than on departmental or intercompany basis. (12 mentions.) *Editor's Note: Colleges fail to realize that the oil industry is highly specialized—that refining, production, exploration, pipe lines are separate industries. An experienced refinery engineer could hardly be expected to interview candidates for the production division.*

7. Interviewers arrive on time and stay strictly within their schedule—with no last minute changes. (10 mentions.)

8. Conduct all business in a direct manner both with the Placement Bureau and the students—using no unethical tactics. See Code of Ethics for Interviewing Procedures, 1949 Issue of Journal of Engineering Education. (8 mentions.)

9. Keep in mind that successful recruiting is almost always tied in with good faculty relationships. Keep in personal contact with Placement Bureaus and college departments during the off season. (4 mentions.)

10. After interviews return to the Placement Office for discussion of candidates before leaving. (4 mentions.)

Other Mentions:

11. Do not ask Placement Directors to make decisions on candidates.

12. Understand the limitations of placement facilities and do not ask the impossible.

13. Arrange for students to make plant visits during class breaks and holidays.

14. Arrange campus recruiting program for June seniors and interview between February and April.

15. College interviewers should familiarize themselves with degrees offered by any given school before writing for interview arrangements.

16. Interviewers should give sufficient weight to part-time work and extra-curricular activities which might have a tendency to lower grade point averages.

17. Courtesy should be shown to the "average" candidate as well as the outstanding one. He should also be given the same type of interview.

18. The ideal interviewing group consists of one technical man and one personnel man.

19. The college interviewer program should be flexible enough to fit into any campus situation.

20. Interviewers should be thoroughly conversant with company arrangements with the Placement Bureau.

20 suggestions from interviewers to placement directors . . .

1. Interviewing rooms should be private and of adequate size. (This point was mentioned by 24 of the 35 companies replying.)

2. Provide complete records and background information on students to be interviewed. (15 mentions.)

3. Keep an orderly appointment schedule. (10 mentions.)

4. Maintain a staff large enough to coordinate visit details with department heads and to meet interviewer needs before, during and after the interviews. (8 mentions.)

5. Provide for conferences with professors regarding job candidates (6 mentions.)

6. Provide a good placement library with an adequate reading room. The library should have various job opportunities cross referenced by industry, job location, job title and degree requirements. (6 mentions.)

7. Have a well-coordinated communications system to insure student notification of company visit, and type of interview. (5 mentions.)

8. Placement bulletin boards should be well organized and of sufficient size to clearly show all company announcements of campus interviews. (4 mentions.)

9. Furnish information in advance about meals, lodging, parking and campus geography. (3 mentions.)

10. See that students fill out application forms before interviewer arrives on the campus. (3 mentions.)

Other Mentions:

11. Closer contact between department heads and Placement Bureaus regarding industry requirements.

12. Proper indoctrination of students as to correct interview practices.

13. Some pre-screening of candidates—if possible.

14. Require students who sign up for interviews to keep appointments.

15. Make provisions for the interviewers to visit the various departments.

16. Notify the company if no one is available for interviews.

17. Keep an impartial attitude toward companies when referring students for jobs.

18. Provide facilities for meetings with the faculty.

19. Help the recruiters contact members of the faculty, and make necessary arrangements for lunch on campus.

20. Provide advisory and counseling services for the student so he will know the companies that offer him the kind of future he seeks.

Continued on next page

College placement directors speak . . .

Q *When did your college start its placement program?*

A Fifteen, or one-third of the colleges replying have established placement bureaus since 1945. Six have been in existence five years or less.

Q *Approximately how many oil company interviewers visited your campus during the 1954-55 school year?*

A Of the 45 colleges replying, 11 reported 137 oil company interviewers visited their campuses in 1945. During the last school year, 1071 oil company interviewers visited 34 of the campuses. One college reported 350 oil representatives visited its campus last year, compared with 50 in 1945.

Q *Have you increased your facilities for company interviews since 1945? To what extent?*

A Forty-three colleges reported considerable expansion of placement facilities and personnel in the past 10 years. Two said no improvement has been made. One placement director said he needs to triple space and number of personnel.

On the other hand, one of the colleges has increased its personnel from 1 to 12 and has 10 times as much office space as in 1945. During the same period job listings have increased from 1 to 3000, placements have increased from 100 to 10,000 and the number of campus interviews has increased from 1 to 250. Another college has tripled its space and expects to triple its present space and personnel within the next three years.

Q *Approximately how many of your students were interviewed by company representatives during 1954-55? How many were hired?*

A Thirteen colleges reported 1161 graduates were interviewed for positions in the refining industry—86 were hired; 8 colleges reported 550 graduates were interviewed for jobs in the petrochemical field—23 were hired; 11 colleges reported 482 graduates were interviewed for pipe line work—51 were hired; 20 colleges reported 1202 graduates were interviewed for jobs in exploration and production—78 were hired.

Q *Has there been a shift in emphasis in the type of student hired?*

A Forty-four colleges said "yes." One said "no." Nearly all agreed there has been a decided increase in demand for engineers, chemists and accountants—particularly in the past five years. One college reported than in 1955, demand for engineers was 5 times the supply, scientists 10 times the supply and accountants 5 times the supply. Another college said each of its graduates in these three fields had at least 10 to 15 job offers.

Twenty colleges say there has been a corresponding increase in demand for liberal arts majors and salesmen in the past three years.

Q *What are the most common faults of company interviewers?*

A 1. Do not properly define qualifications for applicants in advance.
2. Do not inform the college of company decisions. (Numbers 1 and 2 were mentioned many more times than the others as the major faults.)
3. Do not inform the candidate of company decisions (if not hired).
4. Send too much promotional material to the college.
5. Do not properly announce time of arrival or departure.
6. Ask the placement director to make the decision on applicants.
7. Exert pressure on the placement director to get preference in graduate selection.
8. Rude to students.
9. Show prejudice because of racial or religious background.

In almost every instance, placement directors emphasized that the majority of the companies are doing an exceptional job of recruiting. Several colleges mentioned that the federal government is by far the weakest of them all in recruiting practices—sends too many people to interview and stays too long; too much duplication of effort.

One college mentioned that an oil company showed great interest in eight applicants, but never again contacted the students or the placement bureau.

TEN WAYS TO GET STUDENTS TO ATTEND INTERVIEWS

1. **Contact the placement bureau of the college well in advance of the visit and send literature for distribution to students and factulty. *(Most companies replying use this method only.)***
2. **Keep dormitories, fraternity and sorority houses on the mailing list for company material.**
3. **Personal contact throughout the year with the placement bureau and college department heads.**
4. **Conduct year-round public relations program with placement personnel, deans of engineering and the engineering library.**
5. **Advertise in campus newspapers.**
6. **Send copies of all correspondence concerning interviews to department heads as well as placement bureau.**
7. **Send interview notices for posting on college bulletin boards.**
8. **Take active part in placement association work.**
9. **Conduct group meetings whenever possible.**
10. **Sponsor summer employment programs for juniors. They usually discuss the company when they return to college in the fall.**

College interviewers speak . . .

Q *How many colleges did you visit during the 1954-55 school year?*

A One company visited only two colleges while another conducted interviews at 158 schools. The average was 35 colleges.

Q *How many colleges have placement departments? How does this compare with 1954?*

A Most of the companies said all the colleges they contacted had placement facilities of one kind or the other. However, one of the larger companies said that 100 out of 158 colleges contacted had a placement bureau—another reported 130 out of 142. The interviewers all agreed that there has been a remarkable increase in placement bureaus in the past 10 years. One company said there are twice as many.

Q *How many students did you interview for oil company positions? How many were hired?*

A
- Seven companies interviewed 3093 students for positions in the refining industry (one company alone interviewed 2817 students and hired 200). A total of 226 were hired.
- Five companies interviewed 1102 students for petrochemicals—86 were hired.
- Twelve companies interviewed 1432 students for jobs in exploration and production—152 were hired.
- Five companies interviewed 213 students for pipe line jobs—19 were hired.

Q *Is there a trend to improve college placement services?*

A No doubt was left here. Nearly all the companies said college officials are constantly trying to improve their service to students and interviewers alike. There is a need in some colleges to enlarge facilities and increase personnel. Several interviewers mentioned that representatives of industry and college placement officials meet annually to discuss ways of mutual improvement. Placement associations are the sponsors of most of these meetings.

Q *How long does it take to conduct a college interview?*

A Eleven companies said it takes 30 minutes to conduct a successful interview. Seven said 20-30 minutes. Five complete their interviews in 20 minutes. One interviewer said it takes only 10 minutes per interview while another said it takes from 30 to 45 minutes.

Q *Is the interviewee hired by directly contacting the individual, or through the placement bureau?*

A Twenty companies reported that they contact the individual directly when he is hired. Four companies hire through the placement bureau. Three companies make direct contact with the individual, but keep the placement bureau fully informed (many of the companies that contact the individual directly also contact the placement bureau).

Q *What success have you had in getting prospects to attend interviews?*

A Eighteen companies say they have good to excellent success in getting students to attend interviews. Seven companies report fair success—two say attendance is poor.

Q *Has there been a shift in emphasis on the type of students hired?*

A Thirty of the companies said "yes." Major shift has been to mechanical and chemical engineers, chemists and accountants, resulting in the current shortage of graduates in these fields. Five said there was no change of emphasis.

Q *What are the most common faults of college placement departments?*

A
1. Do not properly inform students about job openings. (Was mentioned more times than any other as the major fault.)
2. Do not provide adequate student records for interviews.
3. Do not provide proper facilities for interviews.
4. Do not circulate company literature properly.
5. Do not screen applicants properly in advance.
6. Show lack of interest in cooperating with interviewers.
7. Lack of centralized placement office.
8. Fail to notify interviewer if less than a minimum number of students are available for interviews.
9. Do not follow up to make sure students report for interviews.

The interviewers were unanimous in their general praise of placement bureaus. Many emphasized that the schools have done an outstanding job considering the recent heavy demand on limited facilities and personnel in some of the colleges. Where weaknesses are found they usually can be attributed to overloaded personnel or misplaced personnel in charge, i.e., the associate professor whose interests are solely academic is assigned placement responsibilities in addition to his other duties.

WHAT INTERVIEWERS SEEK IN GRADUATES

1. **Grades—intelligence—mental alertness. *(Mentioned by 26 of the 35 companies replying.)***
2. **Personality. *(15 mentions.)***
3. **Appearance. *(15 mentions.)***
4. **Interest—mental curiosity. *(14 mentions.)***
5. **Maturity. *(14 mentions.)***
6. **Character traits. *(12 mentions.)***
7. **Extra-curricular activities. *(8 mentions.)***
8. **Experience. *(5 mentions.)***
9. **Family background. *(4 mentions.)***
10. **Attitude. *(4 mentions.)***

Turn to Page 270 for other 'As Management Sees It' articles

How to Cope With Hydrogen

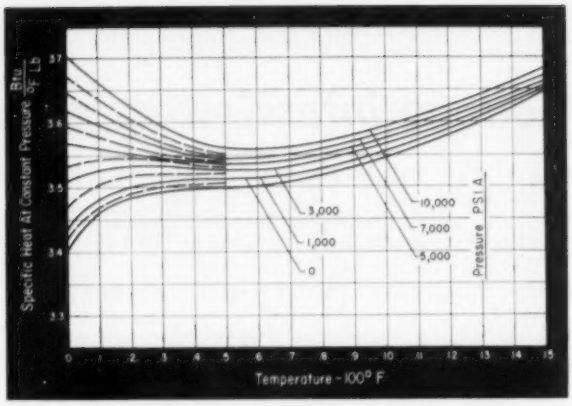


FIGURE 1—Specific heat of hydrogen.

THIS SPECIAL report on hydrogen presents a wealth of useful data and information. While it does not give the answers to all problems associated with hydrogen it does help in process design, mechanical design and maintenance.

The effect of hydrogen on the physical properties of gas mixtures is out of proportion to its size and weight. The determination of physical properties of these mixtures is essential in process calculations. The influence of hydrogen is especially great in fluid flow and heat transfer problems. This special report presents theoretical and practical equations for solving these everyday problems. The collection of graphical data represents hours of literature searching.

One major problem associated with hydrogen attack is the recognization of the particular type. Only after suitable classification can the seriousness of the attack be determined and preventative maintenance planned. The theory of hydrogen attack and the classification of the various types are presented in this special report.

Hydrogen embrittlement is a very insidious phenomenon. Without any previous warning it may exhibit itself with a dramatic equipment failure. This report describes some empirical observations useful in determining hydrogen embrittlement.

All hydrogen problems cannot be solved by the use of high-powered alloys. This report tells the uses and limitations of the presently available alloys and steels. This knowledge is money. Reported here are the characteristics imparted to a steel by the use of various alloying elements. Proper use of these materials can solve the problems of hydrogen blistering, decarburization and cracking.

Thomas L. Sonder

Viscosity Thermal Conductivity Specific Heat Density

Finding the

Frank L. Rubin
Downington Iron Works, Downington, Penn.

HEAT TRANSFER and fluid flow calculations for mixtures containing hydrogen can be made in normal fashion provided one can evaluate properly the viscosity, thermal conductivity, specific heat, and density of the mixture. This article presents methods for making such calculations.

Process calculations involving mixtures containing hydrogen present problems to engineers. Hydrogen has the lowest molecular weight of any substance. Thus the mixture containing a very low weight percent of hydrogen contains a significant volume percentage of hydrogen. The physical properties of hydrogen differ considerably from those of the hydrocarbons and more common gases.

- Specific heat is approximately 3.5 as compared to a more conventional range of 0.25 to 1.0.
- Thermal conductivity is approximately 4 to 10 times greater than that of the more common process fluids.
- Viscosity of hydrogen is somewhat lower than that of the other common fluids.

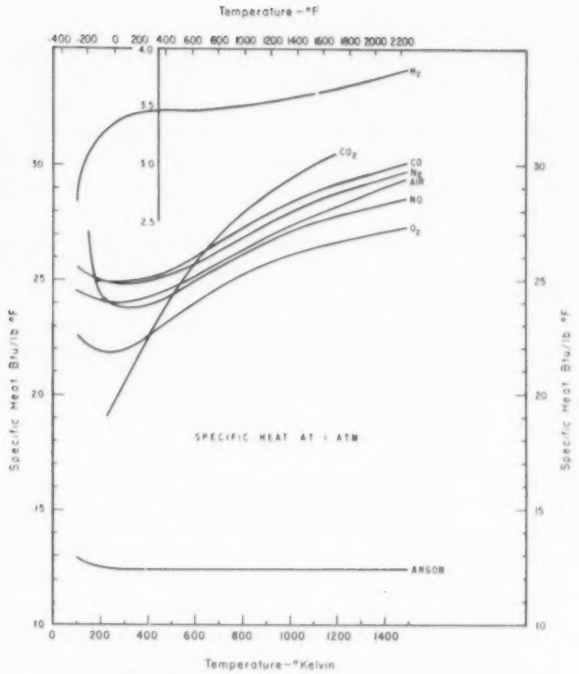

Temperature - °F
-400 -200 0 200 400 600 800 1000 1200 1400 1600 1800 2000 2200
Specific Heat Btu/lb °F
SPECIFIC HEAT AT 1 ATM
ARGON
Temperature - °Kelvin

FIGURE 2—Specific of eight gases at atmospheric pressure.

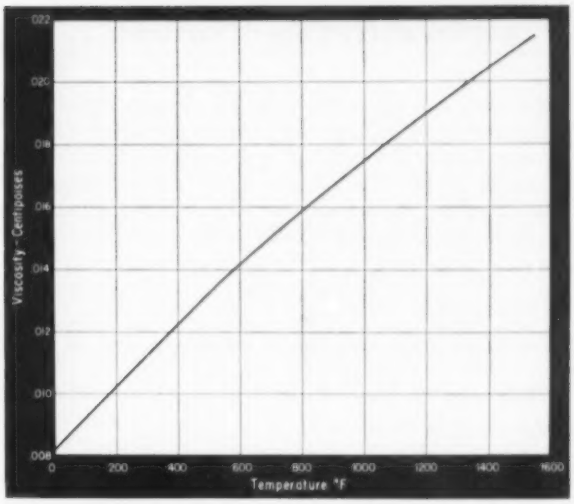


FIGURE 3—Viscosity of hydrogen.

Properties of Hydrogen Mixtures

Here are data you need for solving those fluid flow and heat transfer problems. This short-cut method helps determine physical properties.

The Prandtl number is dimensionless and is equal to cz (2.42) /k. The Prandtl number for hydrogen and several other common gases[2] at various temperatures are shown in Figure 13. The Prandtl number for hydrogen is of comparable magnitude to that of the other gases even though specific heat and thermal conductivity are relatively high. These factors tend to balance out in the Prandtl number relationship.

Process calculations involving mixtures of hydrogen with liquids involve fluid flow for two-phase systems. The method of Chenoweth and Martin[18] is recommended for these problems.

Both viscosity and thermal conductivity are transport properties. These are dependent upon forces between molecules. The energy of interaction between polar molecules is quite different from that of non-polar molecules. Hydrogen has a non-polar molecule.

Recommended methods of determining the properties of hydrogen mixtures for heat transfer and fluid flow are described here. Viscosity and thermal conductivity calculations by different methods are shown. The simplest solutions, which appear to give results suitable for engineering calculations are those of Bromley and Wilke[4] for viscosity and the author's presentation for thermal conductivity.

The density of hydrocarbon vapors is determined from the ideal gas law with an appropriate correction factor, $n = PV/RT$. The correction factor is plotted as a function of the reduced temperature (T/T_c) and reduced pressure (P/P_c).[7] For hydrocarbon mixtures the pseudo-critical temperature and pressure should be used. The average boiling point method[17] is recommended to calculate the pseudo-critical properties.

When gases (H_2,H_2O, H_2S, etc.) are present in a mixture of hydrocarbon vapors, the reduced pressure of the

How to Cope With Hydrogen

hydrocarbon portion should be based upon the effective pressure of $P \sqrt{x_{hc}}$ for the hydrocarbon portion. The correction factor, n, for the other gases should be also determined at an effective pressure equal to the total pressure multiplied by the square root of its mole fraction. The molal volume is then calculated by Amagat's Law.[7]

$$V_m = \frac{RT}{P}(x_{hc}n_{hc} + x_a n_a + \ldots + x_n n_n)$$

Usually the correction factors for gases are equal to 1.0.

The specific heat of hydrogen as a function of pressure and temperature has been presented in a convenient, graphical form[1] (Figure 1).

The effect of pressure upon the specific heat is slight. The temperature effect is unusual. At low pressures the specific heat increases at a decreasing rate and then increases at an increasing rate. At high pressure, the specific heat decreases at a decreasing rate and then increases at an increasing rate. The point of inflection occurs near 500 F.

The specific heat of hydrogen is approximately thirteen times that of the other common gases as shown in Figure 2.[2]

The specific heat of a mixture of gases at low pressure is equal to the sum of the products of the individual weight fractions times the respective specific heats.

$$c_m = x_a c_a + x_b c_b + \ldots x_n c_n \qquad (1)$$

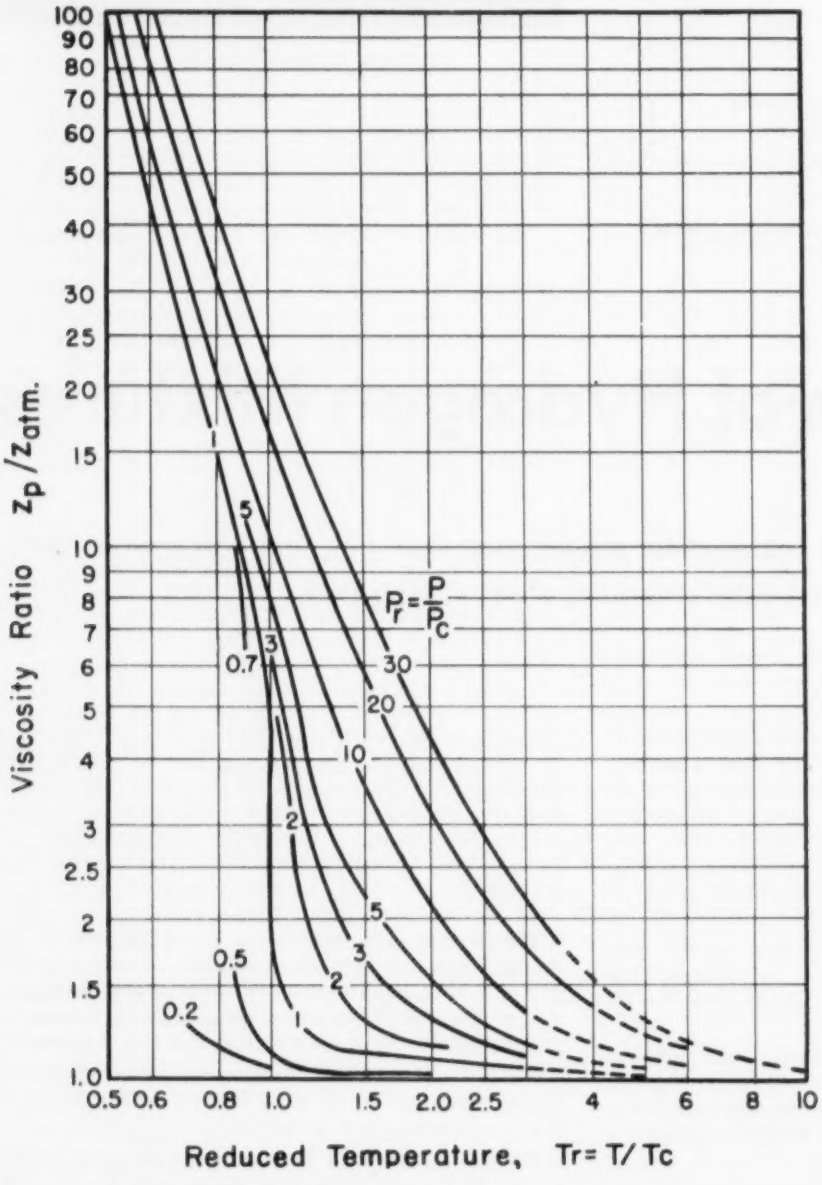


FIGURE 4—Generalized pressure correction to viscosity.

The specific heat of a mixture of gases at high pressure is calculated from enthalpy data. The heat load in the system under consideration should be determined by multiplying the individual weight fractions times the respective enthalpy changes. The specific heat of the mixture is equal to the enthalpy change divided by the temperature change.

$$H = x_a(h_1 - h_2) + x_b(h_1 - h_2) + \ldots + x_n(h_1 - h_2) \qquad (2)$$

$$c_m = \frac{H}{t_1 - t_2} \qquad (3)$$

The viscosity of hydrogen as a function of temperature is shown in Figure 3. The effect of pressure was expected to be small.[1] The recently published data of Hilsenrath & Touloukian[2] shows the effect of pressure on viscosity at 100 atmospheres to be about 1 percent or less for temperatures of 272 F and higher. The viscosity of hydrogen (nitrogen, oxygen, carbon dioxide, and steam) as a function of temperature (—238 to 2192 F) and of pressure (to 100 atmospheres) are given by these authors.[2]

The effect of pressure and temperature upon viscosity has been developed by Uyehara and Watson.[3] A more convenient plot[4] of their data is given in Figure 4. The ratio of viscosity at pressure, P, to the viscosity at one atmosphere, z_p/z_{atm}, as a function of reduced temperature for

TABLE 1
Viscosities of Hydrogen and Nitrogen Under Pressure

Pressure Atmospheres	PSI	VISCOSITY IN CENTIPOISES			
		Temperature 122 F		Temperature 212 F	
		Hydrogen	Nitrogen	Hydrogen	Nitrogen
1	14.7	.00938	.01896	.01030	.02109
50	735	.00952	.01968	.01040	.02169
100	1470	.00963	.02072	.01049	.02250
150	2205	.00973	.02202	.01060	.02351
200	2940	.00983	.02350	.01068	.02464

From Hiroji Iwasaki[5]

various lines of constant reduced pressure is shown.

EXAMPLE—Calculate the viscosity of hydrogen at minus 234 F and 1470 psia. Given viscosity at this temperature and at one atmosphere is 0.0481 centipoise. Critical temperature is minus 400 F. Critical pressure is 175 psia.

$$T_r = \left(\frac{-234 + 460}{-400 + 460}\right) = \frac{226}{60} = 3.77$$

$$P_r = \frac{1470}{175} = 8.4$$

From Figure 4 the viscosity ratio is 1.15

$$z_p = 1.15 \times 0.0481 = 0.0553 \text{ centipoise}$$

The viscosity shown by Hilsenrath and Touloukian[3] is 0.0534 centipoise.

The viscosity of hydrogen and nitrogen mixtures at moderate temperatures (122 and 212 F) and at pressures up to 200 atmospheres are presented[5] in Figures 5 and 6. The data for the pure gases (Table 1) by the same author are in close agreement with Hilsenrath.[2] Iwasaki[5] presents a method for calculating the viscosity of these mixtures.

The viscosities[6] of binary mixtures of hydrogen with ethane, carbon monoxide, oxygen, nitrous oxide, methane, propane and nitrogen as determined by experiment and calculation are given in Table 2. It is of particular interest to note that the viscosity of many of these mixtures is greater than the viscosity of either of the components!

TABLE 2
Viscosities of Binary Mixtures
Viscosity in Centipoises

Mol. % H_2 / °F	VISCOSITY H_2-C_2H_6					
	0.0	45.00	85.15	100.0		
68 EX	.00909	.00987	.00993	.00876	.....	.....
CG	.00909	.00986	.01005	.00876	.....	.....
212 EX	.01142	.01208	.01189	.01033	.....	.....
CG	.01139	.01213	.01197	.01021	.....	.....
392 EX	.01409	.01467	.01412	.01213	.....	.....
CG	.01401	.01469	.01411	.01185	.....	.....
482 EX	.01526	.01583	.01511	.01296	.....	.....
CG	.01522	.01588	.01513	.01265	.....	.....

% H_2 / °F.	VISCOSITY H_2-CO_2					
	0.0	19.93	41.29	78.50	100.0	
81 EX*	.01493	.01501	.01506	.01370	.00891	.....
CG*	.01493	.01507	.01508	.01372	.00889	.....
CD*	.01493	.01509	.01512	.01379	.00889	.....
260 EX	.01944	.01945	.01933	.01713	.01081	.....
CG	.01920	.01926	.01913	.01698	.01065	.....
CD	.01920	.01928	.01918	.01703	.01065	.....
440 EX	.02353	.02358	.02321	.02026	.01256	.....
CG	.02301	.02302	.02275	.01990	.01228	.....
CD	.02301	.02303	.02280	.01998	.01228	.....
530 EX	.02556	.02542	.02506	.02173	.01341	.....
CG	.02479	.02478	.02445	.02130	.01308	.....
CD	.02479	.02479	.02450	.02137	.01308	.....

Mol. % H_2 / °F.	VISCOSITY H_2-O_2					
	0.0	18.35	39.45	60.30	78.08	100.0
81	.02057	.02019	.01925	.01784	.01494	.00889
	.02064	.02021	.01934	.01774	.01524	.00889
	.02064	.02024	.01939	.01782	.01531	.00889
260	.02568	.02507	.02381	.02192	.01858	.01087
	.02567	.02506	.02388	.02178	.01857	.01065
	.02567	.02509	.02394	.02186	.01865	.01065
440	.03017	.02950	.02790	.02556	.02158	.01259
	.03015	.02940	.02795	.02541	.02158	.01228
	.03015	.02943	.02802	.02551	.02168	.01228
530	.03220	.03147	.02978	.02733	.02288	.01381
	.03224	.03140	.02986	.02714	.02302	.01308
	.03224	.03146	.02993	.02721	.02313	.01308

Mol. % H_2 / °F.	VISCOSITY H_2-N_2O					
	0.0	39.89	59.61	78.57	100.0	
81 EX	.01488	.01481	.01451	.01348	.00891	.....
CG	.01489	.01509	.01483	.01376	.00889	.....
260 EX	.01943	.01907	.01849	.01684	.01081	.....
CG	.01936	.01932	.01876	.01710	.01065	.....
440 EX	.02355	.02292	.02206	.01990	.01256	.....
CG	.02338	.02311	.02229	.02009	.01228	.....
530 EX	.02555	.02477	.02376	.02137	.01341	.....
CG	.02525	.02489	.02392	.02150	.01308	.....

Mol. % H_2 / °F.	VISCOSITY H_2-CH_4					
	0.0	28.08	48.55	60.22	92.23	100.0
68 EX	.01087	.01099	.01098	.01086	.00955	.00876
CG	.01092	.01102	.01096	.01083	.00952	.00876
CD	.01092	.01105	.01101	.01088	.00955	.00876
212 EX	.01331	.01337	.01328	.01306	.01132	.01033
CG	.01327	.01329	.01313	.01291	.01115	.01021
CD	.01327	.01333	.01318	.01297	.01119	.01021
392 EX	.01603	.01602	.01587	.01551	.01338	.01213
CG	.01588	.01583	.01557	.01525	.01300	.01185
CD	.01588	.01585	.01561	.01531	.01303	.01185
482 EX	.01725	.01718	.01699	.01662	.01423	.01296
CG	.01709	.01701	.01670	.01634	.01389	.01265
CD	.01709	.01704	.01675	.01641	.01393	.01265

Mol. % H_2 / °F.	VISCOSITY H_2-C_3H_8					
	0.0	37.04	78.82	92.25	100.0	
81 EX	.00817	.00874	.00985	.00970	.00891	.....
CG	.00819	.00892	.00995	.00980	.00889	.....
260 EX	.01070	.01130	.01233	.01194	.01081	.....
CG	.01074	.01152	.01241	.01194	.01065	.....
440 EX	.01308	.01366	.01459	.01392	.01256	.....
CG	.01309	.01390	.01462	.01389	.01228	.....
530 EX	.01422	.01478	.01566	.01485	.01347	.....
CG	.01418	.01499	.01566	.01482	.01308	.....

Mol. % H_2 / °F.	VISCOSITY H_2-N_2					
	0.0	25.00	50.00	75.00	100.0	
−312 EX	.00544	.00540	.00524	.00493	.00362	.....
CG	.00564	.00564	.00552	.00508	.00356	.....
66 EX	.01746	.01700	.01609	.01396	.00882	.....
CG	.01744	.01699	.01605	.01393	.00874	.....

From Hirschfelder, Bird and Spotz[6].
* EX—Experimental data; CG—Calculated using a geometric mean E; CD—Calculated using an E calculated from diffusion.

Hirschfelder, Bird, and Spotz[6] calculated the viscosities (indicated with "CG" and "CD") by using force constants. The author used the Bromley and Wilke[4] method to calculate the viscosities. The experimental viscosities as reported[6] were used for the pure components. The latter method is much less tedious and gives results of a comparable accuracy.

The Viscosity of a Mixture of gases can be determined by the following equation by Maxwell:[7]

$$z_m = \frac{x_1 z_1 \sqrt{m_1} + x_2 z_2 \sqrt{m_2} \ldots + x_n z_n \sqrt{m_n}}{x_1 \sqrt{m_1} + x_2 \sqrt{m_2} + \ldots + x_n \sqrt{m_n}} \quad (4)$$

In a series of papers[1, 8, 9] Wilke and others developed a method to determine the viscosity of a gas mixture. These equations are:

$$z_m = \frac{z_1}{1 + \frac{x_2}{x_1}\phi 12} + \frac{z_2}{1 + \frac{x_1}{x_2}\phi 21} \quad (5)$$

$$\phi_{12} = \frac{\left[1 + \left(\frac{z_1}{z_2}\right)^{1/2}\left(\frac{m_2}{m_1}\right)^{1/4}\right]^2}{\frac{4}{\sqrt{2}}\left[1 + \frac{m_1}{m_2}\right]^{1/2}} \quad (6)$$

$$\phi_{21} = \frac{\left[1 + \left(\frac{z_2}{z_1}\right)^{1/2}\left(\frac{m_1}{m_2}\right)^{1/4}\right]^2}{\frac{4}{\sqrt{2}}\left[1 + \frac{m_2}{m_1}\right]^{1/2}} \quad (7)$$

Generalized plots of Function ϕ for gas mixtures are

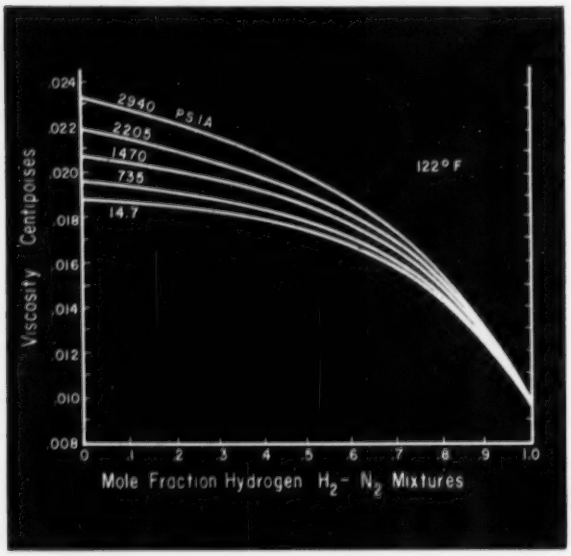


FIGURE 5—Viscosity of hydrogen-nitrogen mixtures at 122 F.

shown in Figures 7 and 8.

EXAMPLE—Calculate the viscosity of a 59.61 percent hydrogen-nitrous oxide mixture at 81 F.

	Hydrogen	Nitrous Oxide
Viscosity (centipoises) at 81 F.	0.00891	0.01488
Molecular weight	2.016	44.02

SOLUTION—by the Maxwell equation (4)

$$z_m = \frac{(0.5961)(0.00891)\sqrt{2.016} + (0.4039)(0.01488)\sqrt{44.02}}{0.5961\sqrt{2.016} + 0.4039\sqrt{44.02}}$$

$$= 0.01345 \text{ centipoise.}$$

Experimental result[2] is 0.1451 centipoise.
Calculated result is 7.3 percent lower.

SOLUTION—by the Bromley and Wilke method

$$\frac{m_1}{m_2} = \frac{2.016}{44.02} = 0.0459$$

$$\frac{z_1}{z_2} = \frac{.00891}{.01481} = 0.600$$

From Figure 4 $\phi_{12} = 2.5$

$$\frac{m_2}{m_1} = \frac{44.02}{2.016} = 21.8$$

$$\frac{z_2}{z_1} = \frac{.01481}{.00891} = 1.67$$

From Figure 8 $\phi_{21} = 0.19$

By equation (5)

$$z_m = \frac{.00891}{1 + \frac{.4039}{.5961}(2.5)} + \frac{.01488}{1 + \frac{.5961}{.4039}(0.19)} = .01494 \text{ centipoise.}$$

Calculated result is 3.0 percent higher than experimental result.

Hirschfelder, Curtiss and Bird[10] present the development of a rigorous kinetic theory for monatomic gases. The final result of this development is the expression of the various transport coefficients in terms of a set of integrals.

These depend upon the force law which is assumed for the molecular interaction. The integrals are evaluated and the calculations are made of the transport coefficients—including viscosity and thermal conductivity—for spherically symmetrical potential functions. The most useful potential function is the Lennard-Jones (6-12) potential. The transport phenomena of molecules with spherically symmetric force fields are well understood. For polar gases and for molecules, which lack spherical symmetry, more work must be done.

The coefficient of viscosity of a pure gas is given by

$$z = \frac{266.93\sqrt{mK}}{D^2 W 10^5} \quad (8)$$

The Force Constants for the Lennard-Jones potential are given in Table I-A[10] for various gases. In this article we refer to the collision diameter (in angstroms) as D and the potential parameter (in degrees Kelvin) as E. The appropriate integral, designated as W for viscosity and thermal conductivity calculations is given in Table I-M.[10] It is necessary to determine the Reduced Temperature, T*, to utilize Table I-M.[10]

$$T^* = K/E \quad (9)$$

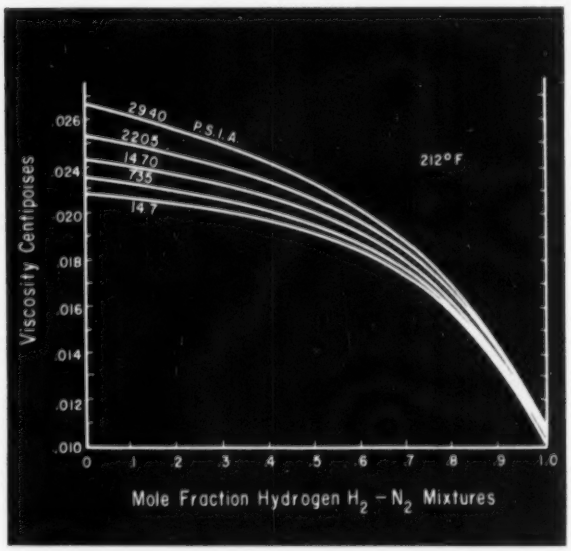


FIGURE 6—Viscosity of hydrogen-nitrogen mixtures at 212 F.

Equation 8.2-19 of the text[10] introduces a correction factor, which varies from zero to 0.8 percent.

EXAMPLE—Calculate the viscosity of methane at 350 F.

$$m = 16.04$$
$$K = 450 \text{ K}$$

From Table I-A[10] the force constants for methane are
$E = 137$ K and $D = 3.882$ angstroms.

$$T^* = K/E = 450/137 = 3.28$$

From Table I-M[10] $W = 1.016$

By Equation (8)

$$z = \frac{266.93\sqrt{(16.04)(450)}}{(3.882)^2(1.016)(10)^5} = 0.0148 \text{ centipoise}$$

The viscosity of a binary mixture can be determined from

$$z_{12} = \frac{266.93\sqrt{2m_1m_2K/(m_1 + m_2)}}{10^5 D_{12}^2 W_{12}} \quad (10)$$

where z_{12} is the viscosity of a hypothetical substance of molecular weight $2m_1m_2/(m_1 + m_2)$ and the molecules interact according to a potential curve specified by the

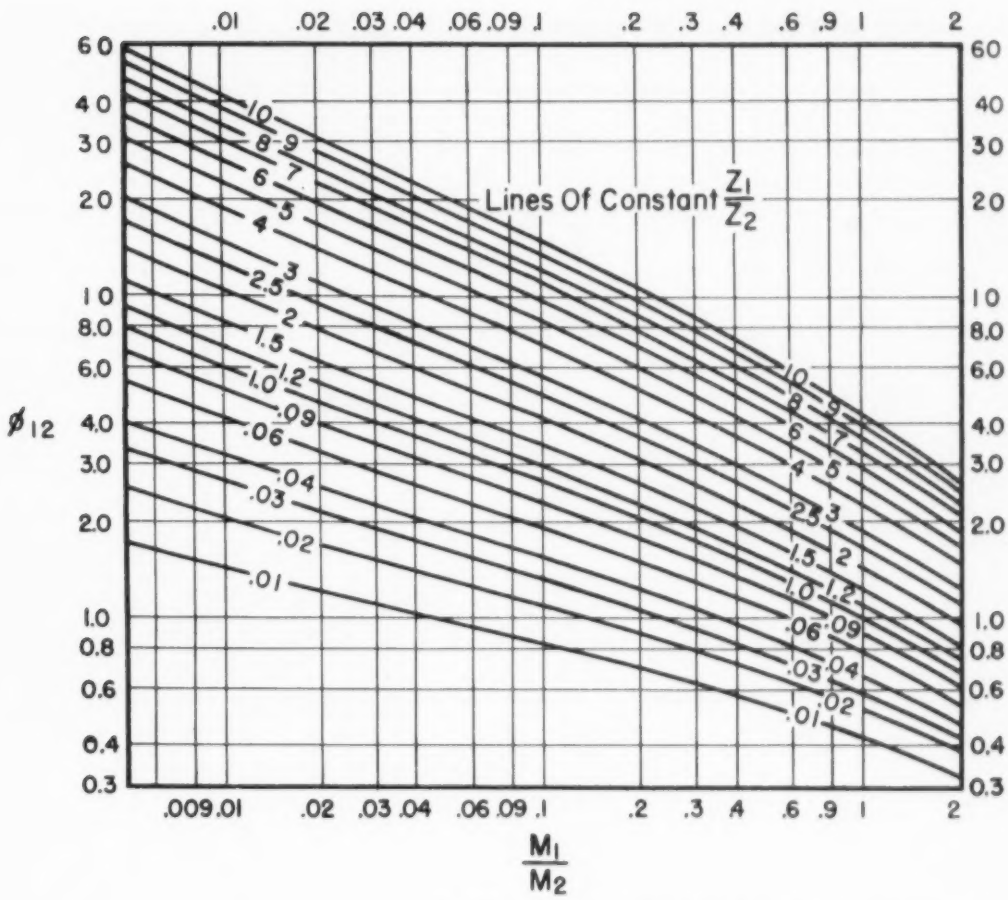


FIGURE 7—Generalized plot of function ϕ for gas mixture viscosities.

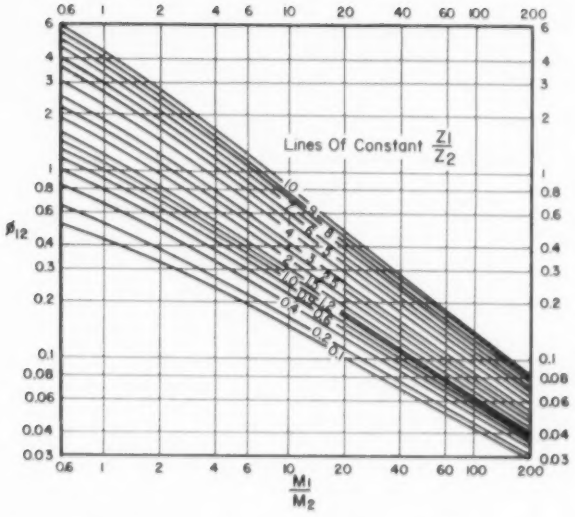


FIGURE 8—Generalized plot of function ϕ for gas mixture viscosities.

interaction parameters D_{12} and W_{12}.

EXAMPLE—Calculate the viscosity of a mixture of 23.37 mole percent nitrogen and 76.63 mole percent CO at 226.9 C.

SOLUTION: at 226.9 C, K = 500.1 Kelvin.

Gas	(Angstroms)	(Kelvin)	Source	Mol. Wt.
N_2	$D_1 = 3.681$*	$E_1 = 91.5$*	Table I-A[10]	28.02
CO	$D_2 = 3.706$	$E_2 = 88.0$	Table I-A[10]	28.01
N_2-CO	$D_{12} = 3.694$	$E_{12} = 89.7$	See below	

$D_{12} = 0.5\ (3.681 + 3.706) = 3.694$ angstroms

$E_{12} = \sqrt{(9.15)\ (88.0)} = 89.7$ K

	$T^* = K/E$	W (from Table I-M[10])
T_1^*	$= 500.1/91.5 = 5.446$	0.9127
T_2^*	$= 500.1/88.0 = 5.683$	0.9060
T_{12}^*	$= 500.1/89.7 = 5.557$	0.9093

From Table I-N[10] $A_{12}^* = 1.102$

* Data used in "Molecular Theory of Gases and Liquids"[10] page 569, although these values are recommended for use below 300 Kelvin.

Equation (8)

$$Z_1 = \frac{266.93\sqrt{(28.02)\ (500.1)}}{(3.681)^2\ (0.9127)\ 10^6} = 0.02555 \text{ centipoise}$$

$$Z_2 = \frac{266.93\sqrt{(28.01)\ (500.1)}}{(3.706)^2\ (0.9060)\ 10^6} = 0.02539 \text{ centipoise}$$

Equation (10)

$$Z_{12} = \frac{266.93\sqrt{(28.02)\ (28.01)\ (500.1)/(28.02 + 28.01)}}{(3.694)^2\ (0.9093)\ 10^6} = .02546 \text{ centipoise}$$

The viscosity of the binary mixture is given by Equation (11).

$$\frac{1}{(Z_{mix})_1} = \frac{X_2 + Y_2}{1 + Z_2} = X\left[\frac{1 + (Y_2/X_2)}{1 + Z_2}\right] \qquad (11)$$

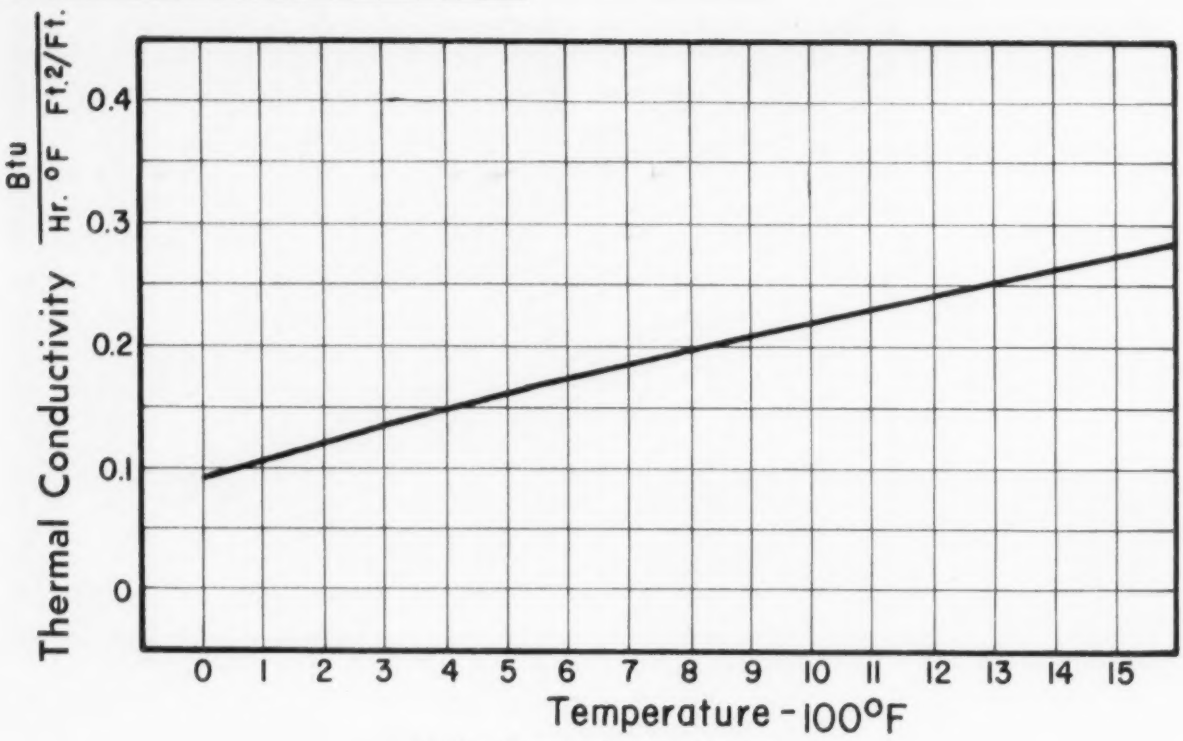


FIGURE 9—Thermal conductivity of hydrogen.

TABLE 3
Thermal Conductivity
Thermal Conductivity in BTU/hr. sq. ft. °F./ft

	PRESSURE—Pounds/Square Inch Absolute						
	°F	14.22	1422	2844	4266	5688	7110
Hydrogen	59	.1014	.1042	.1080	.1103	.1111	.1116
	212	.1222	.1236	.1262	.1274	.1283	.1288
	392	.1458	.1467	.1486	.1496	.1503	.1504
	572	.1693	.1700	.1716	.1726	.1729	.1731
Nitrogen	59	.0145	.0163	.0211	.0251	.0273	.0308
	212	.0178	.0184	.0219	.0254	.0272	.0306
	392	.0213	.0217	.0238	.0263	.0278	.0307
	572	.0249	.0250	.0265	.0286	.0298	.0323
Air	68	.0149	.0161	.0220	.0262	.0292	....
	212	.0177	.0178	.0217	.0249	.0271	....
	356	.0209	.0211	.0236	.0443	.0281	....
Methane	58	.0194	.0261	.0379	.0437	.0473	.0487
	212	.0262	.0284	.0358	.0404	.0432	.0442
	392	.0344	.0350	.0405	.0423	.0445	.0451
Carbon Dioxide	127	.0111	.0323	.0485	....	....	....
	185	.0126	....	.0374	.0460	....	....
	212	.0135	.0196	.0353	.0444	....	....
	302	.0161	.0178	.0283	.0370	....	....
	392	.0185	.0191	.0259	.0335	....	....

From Stolyanov, Ipatlev and Teodorovich[11].

$$X_z = \frac{x_1^2}{(z_1)_1} + \frac{2x_1x_2}{(z_{12})_1} + \frac{x_2^2}{(z_2)_1} \qquad (11A)$$

$$Y_z = 0.6\,(A_{12}^*)\left\{\frac{x_1^2}{(z_1)_1}\left(\frac{m_1}{m_2}\right) + \frac{2x_1x_2}{(z_{12})_1}\left(\frac{(m_1+m_2)^2}{4m_1m_2}\right)\left(\frac{(z_{12})_1^2}{(z_1)_1\,(z_2)_1}\right) + \frac{x_2^2}{(z_2)_1}\left(\frac{m_2}{m_1}\right)\right\} \qquad (11B)$$

$$Z_z = 0.6\,(A_{12}^*)\left\{x_1^2\left(\frac{m_1}{m_2}\right) + 2x_1x_2\left[\left(\frac{(m_1+m_2)^2}{4m_1m_2}\right)\left(\frac{(z_{12})_1}{(z_1)_1}\right) + \frac{(z_{12})_1}{(z_{12})_1} - 1\right)\right] + x_2^2\,\frac{m_2}{m_1} \qquad (11C)$$

Solving Equation (11), using data from the proceeding example, gives the concentration dependence of the viscosity of N_2 — CO mixtures at 226.9 C

$$Z_{mix} = \frac{16613x_1^2 + 33214x_1x_2 + 16611x_2^2}{(10^5)\,(6.5023x_1^2 + 13.0455x_1x_2 + 6.5423x_2^2)}$$

For $x_1 = 0.2337 \quad x_2 = 0.7763$

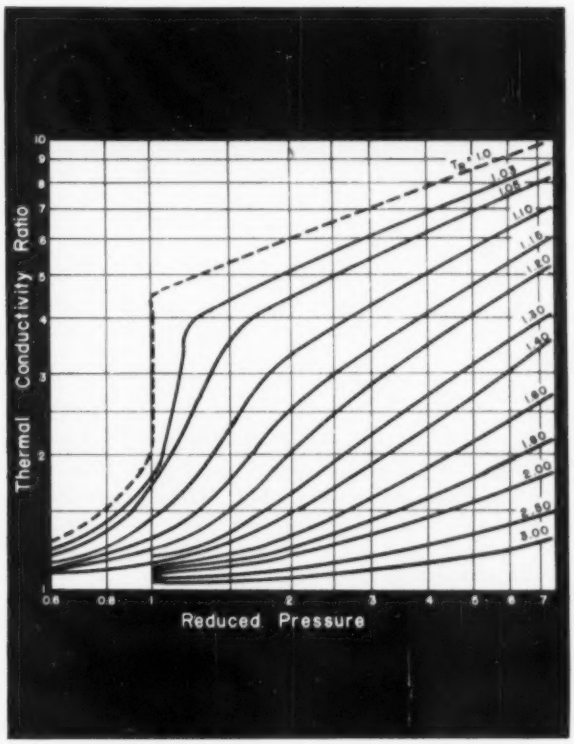
$Z_{mix} = .02542$ centipoise

Experimental data give 0.02550 centipoise.

Thermal conductivity of hydrogen as a function of temperature has been presented in a convenient form[1] and is reproduced in Figure 9. The effect of pressure was expected to be small and recently published[11] Russian data, extending to some 485 atmospheres, confirm this as shown in Table 3. There is a 10 percent increase in conductivity at 59 F and a 2.2 percent increase at 572 F. The thermal conductivity of nitrogen, air, methane, and carbon dioxide under pressure were also investigated and the results are presented. Pressure greatly effects the thermal conductivity of these gases.

The effect of pressure and temperature upon thermal conductivity has been developed by Lenoir, Junk, and Comings.[12] The ratio of thermal conductivity at pressure, P, to the thermal conductivity at one atmosphere, k_p/k_{atm}, as a function of reduced pressure for various lines of constant reduced temperature is shown in Figure 11. The Russian data extend considerably beyond the range of this figure. (eg. The reduced pressure of hydrogen at the highest tabulated value is 40, while the curve extends to a reduced pressure of 7.)

The thermal conductivities of gaseous mixtures con-



Recent work indicates that this figure predicts values approximately 40 percent too high for ethane and 60 percent too high for propane in some regions. The behavior of the more complex organic compounds is more complicated than is shown by this figure.

FIGURE 10—Generalized pressure correction to thermal conductivity.

taining hydrogen are presented[13] in Table 4.

Lindsay and Bromley[14] developed the following relationship for the thermal conductivity of mixtures.

$$k_m = \frac{k_1}{1 + A_{12}\frac{x_2}{x_1}} + \frac{k_2}{1 + A_{21}\frac{x_1}{x_2}} \qquad (12)$$

$$A_{12} = 0.25\left\{1 + \left[\frac{z_1}{z_2}\left(\frac{m_2}{m_1}\right)^{0.14}\frac{\left(1+\frac{S_1}{T}\right)}{\left(1+\frac{S_2}{T}\right)}\right]^{0.5}\right\}^2\frac{\left(1+\frac{S_{12}}{T}\right)}{\left(1+\frac{S_1}{T}\right)} \qquad (13)$$

The same expression gives A_{21} when the subscripts are interchanged.

$S = 1.5\,T_B$

$S = 142$ Kelvin for hydrogen, deuterium, helium

$S_{12} = \sqrt{S_1 S_2}$ for nonpolar mixtures

$S_{12} = 0.733\sqrt{S_1 S_2}$ for polar mixtures with steam or ammonia

Brokaw[13] developed a simpler relationship for the thermal conductivity of a nonpolar gas mixture.

$$k_m = a\,k_{SM} + (1 - a)\,k_{RM} \qquad (14)$$

$$k_{SM} = x_1 k_1 + x_2 k_2 \qquad (15)$$

$$\frac{1}{k_{RM}} = \frac{x_1}{k_1} + \frac{x_2}{k_2} \qquad (16)$$

The dimensionless factor, a, is presented in Figure 11. The author has developed an extremely simple equation

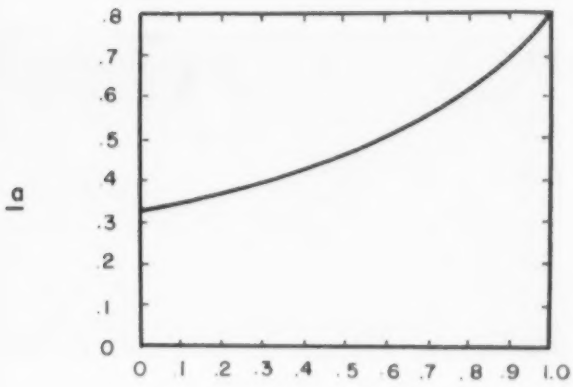


FIGURE 11—Dimensionless factor, a.

for the thermal conductivity of a gas mixture containing hydrogen.

$$k_m = f\left[\left(\frac{x_1 + X_1}{2}\right)k_1 + \left(\frac{x_2 + X_2}{2}\right)k_2\right] \qquad (17)$$

The dimensionless factor, f, is presented in Figure 12. This empirical relationship represents all the data in Table 4 with an accuracy of 3.3 percent and a maximum deviation of 8.6 percent.

Hirschfelder, Curtiss, and Bird[10] present the following methods for determining the thermal conductivity of a

TABLE 4

Thermal Conductivities of Binary Mixtures, Containing Hydrogen

Gas Pair	Literature Reference	Temperature °F	Mole Fraction Hydrogen	Thermal Conductivity Btu/Hr. Sq. Ft. °F./Ft.
H_2-CO_2	18	32	0	0.00871
			0.142	.01380
			0.355	.02420
			0.50	.03265
			0.75	.0549
			0.901	.0762
			1.00	.0978
H_2-N_2	18	32	0.0	0.01331
			0.159	.01936
			0.390	.03073
			0.652	.0469
			0.803	.06215
			1.00	.0978
H_2-N_2O	18	32	0.0	0.0092
			0.209	.01718
			0.386	.02590
			0.599	.0411
			0.812	.0658
			1.00	.0978
H_2-CO	18	32	0.0	0.01283
			0.163	.01936
			0.272	.02492
			0.566	.0436
			0.634	.0506
			0.794	.0653
			1.00	.0978
H_2-C_2H_4	18	77	0.0	0.01277
			0.1698	.02082
			0.3140	.02778
			0.5137	.0409
			0.6116	.04985
			0.8549	.0796
			1.00	.1058
H_2-CO_2	18	77	0.0	0.00987
			0.047	.01072
			0.193	.01833
			0.496	.0366
			0.9059	.0847
			0.9658	.0973
			1.00	.1058
H_2-CO_2	18	32	0.0	0.00821
			0.1701	.0147
			0.3698	.02563
			0.6068	.0417
			0.8546	.0677
			1.00	.1058

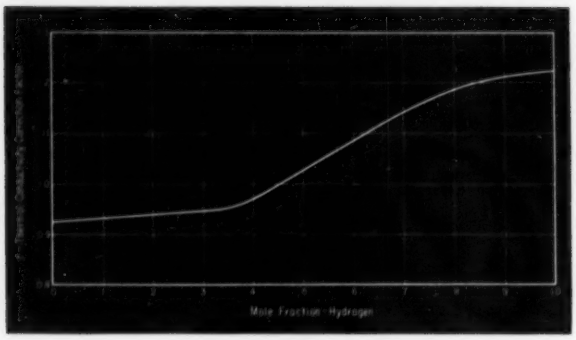


FIGURE 12—Dimensionless factor, f.

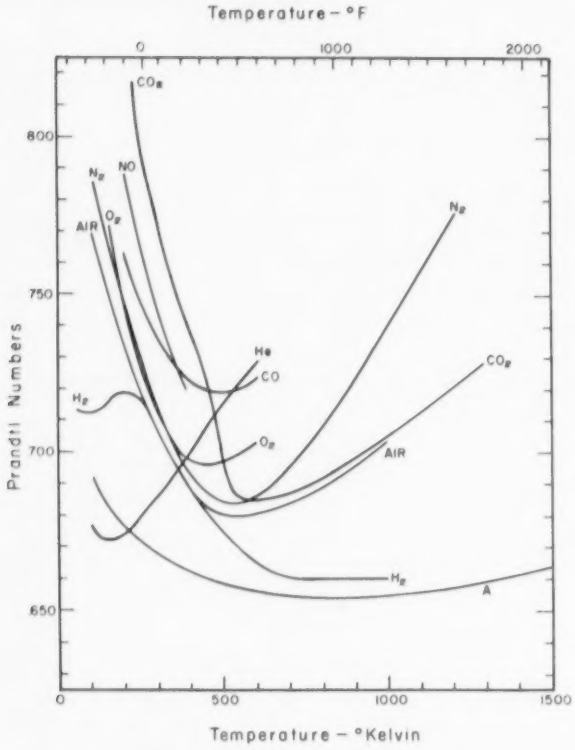


FIGURE 13—Prandtl number for nine gasses.

gas and of a gaseous mixture.

$$k = \frac{0.0482\ \sqrt{K/m}}{D^2 W}\left[\frac{4}{15} \cdot \frac{C}{R} + \frac{3}{5}\right] \qquad (18)$$

$\left[\frac{4}{15} \cdot \frac{C}{R} + \frac{3}{5}\right]$ is a factor for the transfer of energy between translational and internal degrees of freedom. C, the heat capacity per mole, is equal to 3R/2 for monatomic gases. Thus, the factor reduces to 1.0 for monatomic gases (He, Ne, A, Kr, Xe.)

A higher approximation introduces correction factors to increase the accuracy of the calculation. These factors vary from plus 1.0001 to 1.0125 and are ignored in this presentation. Refer to equation 8.2—32 of the text.[10]

Hirschfelder[10] presents the ratios of calculated to experimental conductivities as shown in the Tables 8.4—10[10] and 8.4—11.[10] Also tabulated are the factors for the transfer of energy.

EXAMPLE—Calculate the thermal conductivity of hydrogen at 32 F.

Use Equation (18).

$$K = 273.16 \text{ Kelvin} \quad m = 2.016$$

From Table I-A[10] $D = 2.968$ angstroms $\quad E = 33.3$ Kelvin

From Table 8.4-10 and 8.4-11[10] $\left[\frac{4C}{15R} + \frac{3}{5}\right] = 1.255$

$$T^* = K/E = 273.16/33.3 = 8.203$$

From Table I-M[10] $W = 0.8506$

$$k = \frac{0.0482\ \sqrt{273.16/2.061}}{(2.968)^2\,(0.8506)}(1.255) = 0.0939 \text{ Btu/hrs. sq. ft. F/ft.}$$

The thermal conductivity of a mixture is determined from equation

$$k_{12} = \frac{0.0482\ \sqrt{K(m_1 + m_2)/2m_1m_2}}{D_{12}^2\, W_{12}} \qquad (19)$$

where k_{12} is the thermal conductivity of a hypothetical substance of molecular weight $2m_1m_2/(m_1 + m_2)$ and the molecules interact according to the potential curve specified by the interaction parameters D_{12} and W_{12}. (Refer to example for viscosity of a mixture for methods of determining D_{12} and W_{12}.)

In terms of this quantity and the thermal conductivities of the pure components, the thermal conductivity of a mixture of monatomic gases may be written as

$$\frac{1}{(K_{mix})_1} = \frac{X_k + Y_k}{1 + Z_k} \qquad (20)$$

There is at present no rigorous method for calculating the thermal conductivity of mixtures of polyatomic gases. However, an empirical method is suggested by Hirschfelder, et al.[10] First, calculate for the mixture the quantity given by the above Equation (19). The result is denoted by k_{mon}. If the experimental values of k for the pure gases are known, then for each of the components compute the ratio . . .

$$r = \frac{k_1\ expt}{k_{1\ mon}} \qquad (21)$$

An empirical expression for the mixture is . . .

$$k_{mix} = k_{mon}\,(x_1r_1 + x_2r_2) \qquad (22)$$

$$X_k = \frac{x_1^2}{(k_1)_1} + \frac{2x_1x_2}{(k_{12})_1} + \frac{x_2^2}{(k_2)_1} \qquad (20A)$$

$$Y_k = \frac{x_1^2}{(k_1)_1}\,U^{(1)} + \frac{2x_1x_2}{(k_{12})_1}\,U^{(y)} + \frac{x_2^2}{(k_2)_1}\,U^{(2)} \qquad (20B)$$

$$Z_k = x_1^2\,U^{(1)} + 2x_1x_2\,U^{(z)} + x_2^2\,U^{(2)} \qquad (20C)$$

$$U^{(1)} = \frac{4}{15}\,A_{12}^* - \frac{1}{12}\left(\frac{12}{5}\,B_{12}^* + 1\right)\frac{m_1}{m_2} + \frac{1}{2}\cdot\frac{(m_1 - m_2)^2}{m_1m_2} \qquad (20D)$$

$$U^{(2)} = \frac{4}{15}\,A_{12}^* - \frac{1}{12}\left(\frac{12}{5}B_{12}^* + 1\right)\frac{m_2}{m_1} + \frac{1}{2}\,\frac{(m_1 - m_2)^2}{m_1m_2} \qquad (20E)$$

$$U^{(y)} = \frac{4}{15}\,A_{12}^*\left[\frac{(m_1 + m_2)^2}{4m_1m_2}\right]\frac{(k_{12})_1^2}{(k_1)_1\,(k_2)_1} - \frac{1}{12}\left(\frac{12}{5}B_{12}^* + 1\right) - \frac{5}{32}\,A_{12}^*\left(\frac{12}{5}\,B_{12}^* - 5\right)\frac{(m_1 - m_2)^2}{m_1m_2} \qquad (20F)$$

$$U^{(z)} = \frac{4}{15}\,A_{12}^*\left[\left(\frac{(m_1 + m_2)^2}{4m_1m_2}\right)\left(\frac{(k_{12})_1}{(k_1)_1} + \frac{(k_{12})_1}{(k_{12})_1}\right) - 1\right] - \frac{1}{12}\left(\frac{12}{5}\,B_{12}^* + 1\right) \qquad (20G)$$

EXAMPLE—Calculate the thermal conductivity at 77 F. of a 61.1 percent hydrogen-ethylene mixture.

Properties—

$x_1 = 0.611 \qquad x_2 = 0.389$

$z_1 = 0.00953 \qquad z_2 = 0.0098$

$m_1 = 2.016$ $\quad m_2 = 28.05$

$T_{B1} = 37$ Rankin $\quad T_{B2} = 305$ Rankin

$S_1 = 1.5 \times 37 = 55.5$ $\quad S_2 = 1.5 \times 305 = 457$

$k_1 = 0.1058$ $\quad k_2 = .01277$

Solution by Lindsay and Bromley method.

By Equation (13)

$$A_{12} = 0.25\left\{1+\left[\frac{.00953}{.0098}\left(\frac{28.05}{2.016}\right)^{0.75}\frac{\left(1+\frac{55.5}{537}\right)}{\left(1+\frac{457}{537}\right)}\right]^{0.5}\right\}^2 \frac{\left(1+\frac{\sqrt{(55.5)(457)}}{537}\right)}{\left(1+\frac{55.5}{537}\right)}$$

$A_{12} = 2.72$

$$A_{21} = 0.25\left\{1+\left[\frac{.0098}{.00953}\left(\frac{2.016}{28.05}\right)^{0.75}\frac{\left(1+\frac{457}{537}\right)}{\left(1+\frac{55.5}{537}\right)}\right]^{0.5}\right\}^2 \frac{\left(1+\frac{\sqrt{(457)(55.5)}}{537}\right)}{\left(1+\frac{457}{537}\right)}$$

$A_{21} = 0.388$

By Equation (12)

$$k_m = \frac{0.1058}{1+2.72\left(\frac{0.389}{0.611}\right)} + \frac{0.01277}{1+0.388\left(\frac{0.611}{0.389}\right)} = .0465$$

Solution by the Brokaw Method.

By Equation (15)

$k_{RM} = (0.611)(0.1058) + (.389)(0.01277) = .0695$

By Equation (16)

$$\frac{1}{k_{RM}} = \frac{0.611}{0.1058} + \frac{0.389}{0.01277} = 36.28$$

$k_{RM} = .0276$

From Figure 11, "a" = 0.50

By Equation (14)

$k_m = 0.50 \times .0695 + (1 - 0.50)\ .0276 = .0496$

By the author's method—Equation (17)

From Figure 12 $\quad f = 1.092$

$$x_1 = \frac{0.611 \times 2.016}{(0.611 \times 2.016) + (0.389 \times 28.05)} = 0.101$$

$x_2 = 1.0 - 0.101 = 0.899$

$$k_m = 1.092\left[\left(\frac{0.611+0.101}{2}\right)(0.1058) + \left(\frac{0.389+.899}{2}\right)(.01277)\right] = 0.0500 \text{ Btu/hr.-sq. ft.-F/ft.}$$

Thermal conductivity of mixture.

Table 4	0.04985
Equation (12)	0.0465
Equation (14)	0.0496
Equation (17)	0.0500

NOMENCLATURE

A — dimensionless constant (Lindsay & Bromley equation)
A* — the quantity A* for calculating the transport coefficients of mixtures for the Lennard-Jones (6-12) potential
a — dimensionless factor (Brokaw equation)
B* — the quantity B* for calculating the transport coefficients of mixtures for the Lennard-Jones (6-12) potential
C — specific heat at constant volume, calories per gram mole per degree Kelvin
c — specific heat at constant pressure—Btu/lb. F.
D — collision diameter in angstroms
E — potential parameter in degrees Kelvin
f — dimensionless factor (author's equation)
H — enthalpy change—Btu
h — enthalpy—Btu/lb.
K — temperature—degrees Kelvin
k — thermal conductivity—Btu/hr. sq. ft. F./ft.
m — molecular weight
P — pressure—lb./sq. in. absolute
R — gas constant, calories/degrees Kelvin-gram mole or lb./sq. in.-cu. ft./mole per degree Rankin
S — Sutherland constant, degrees Rankin
T — temperature—degrees Rankin
T* — reduced temperature—dimensionless (T* = K/E)
t — temperature—degrees Fahrenheit
V — molal volume—cu. ft./mole
W — integral for calculating viscosity and thermal conductivity (as well as other properties) for the Lennard-Jones (6-12) potential. $W = \Omega^{2,2*}$ in "Molecular Theory of Gases and Liquids."[10]
X — weight fraction
x — mole fraction
z — viscosity—centipoises
ϕ — function of molecular weights and viscosities

Subscripts:

a,b,n — components a,b,n
atm — one atmosphere (14.7 lb./sq. in.)
B — boiling point at one atmosphere
c — critical point
hc — hydrocarbon
m — mixture
p — absolute pressure, lb./sq. in.
r — reduced (temperature or pressure)
RM — reciprocal mixing
SM — simple mixing
1,2 — temperatures 1 and 2, or components 1 and 2
12 — interaction of components 1 and 2

LITERATURE CITED

[1] Granet, Irving, Petroleum Refiner, Vol. 33, May, 1954, 205.
[2] Hilsenrath, J., and Y. S. Touloukian, Trans. ASME, Vol. 76, August, 1954, 967.
[3] Uyehara, O. A., and K. M. Watson, Natl. Petroleum News, Vol. 36, R764 (1944).
[4] Bromley, L. A., and C. R. Wilke, Ind. & Eng. Chem., Vol. 43, 1641 (1951).
[5] Iwasaki, Hiroji, Science Reports of the Research Institutes, Tohoku University (Sci. Rep. Ritu, A-Vol. 6, No. 3), Sendai, Japan, June, 1954, Page 296-307.
[6] Hirschfelder, J. O., R. B. Bird and E. L. Spotz, Chem. Rev., 44, 205, (1949).
[7] Maxwell, J. B., Data Book on Hydrocarbons, Van Nostrand Co. (1950).
[8] Buddenberg, J. W., and C. R. Wilke, Ind. & Eng. Chem., Vol. 41, 1345 (1949).
[9] Wilke, C. R., J. Chem. Phys., Vol. 18, 517 (1950).
[10] Hirschfelder, J. O., C. F. Curtiss and R. B. Bird, Molecular Theory of Gases and Liquids, John Wiley and Sons (1954).
[11] Stolyanov, E. A., V. V. Ipatlev and V. P. Teodorovich, Zhur, Fiz. Khim., Vol. 24, 166-76 (1950).
[12] Lenoir, J. M., W. A. Junk and E. W. Comings, Chem. Eng. Progress, Vol. 49, 539 (1953).
[13] Brokaw, R. S., Ind. & Eng. Chem., Vol. 47, 2398 (1955).
[14] Lindsay, A. L., and L. A. Bromley, Ind. & Eng. Chem., Vol. 42, 1508 (1950).
[15] Ibbs, T. L., and A. A. Hirst, Proc. Roy. Soc. (London), A 123, 134 (1929).
[16] Kornfeld, G., and K. Hilferding, Z. Physick. Chem. Bodenstein-Festband, 792 (1931).
[17] Smith, R. L., and K. M. Watson, Ind. & Eng. Chem., Vol. 29, 1408 (1937).
[18] Chenoweth, J. M., and M. W. Martin, Petroleum Refiner, Volume 34, 151 (1955).
[19] Getman, F. H., and F. Daniels, "Outlines of Physical Chemistry," Seventh Edition, P. 77, Wiley (1943).

Meet the Author

FRANK L. RUBIN has a background of some 15 years with the chemical, petrochemical, petroleum and power industries. Most of that time has been spent in the design of heat-transfer equipment. With Catalytic Construction Company before joining Dowington he served three years as senior job engineer with special emphasis on heat-transfer problems. His work was on AEC projects, chemical plants and refineries. He also had been with The Lummus Company, in its Heat Exchanger division, and with Stauffer Chemical Company, assigned to Research division. He is a registered professional engineer in Pennsylvania and New York. He holds a B.A. degree from Brooklyn College, a chemical engineering degree from Cooper Union School of Engineering, and has completed graduate studies at The Polytechnic Institute of Brooklyn.

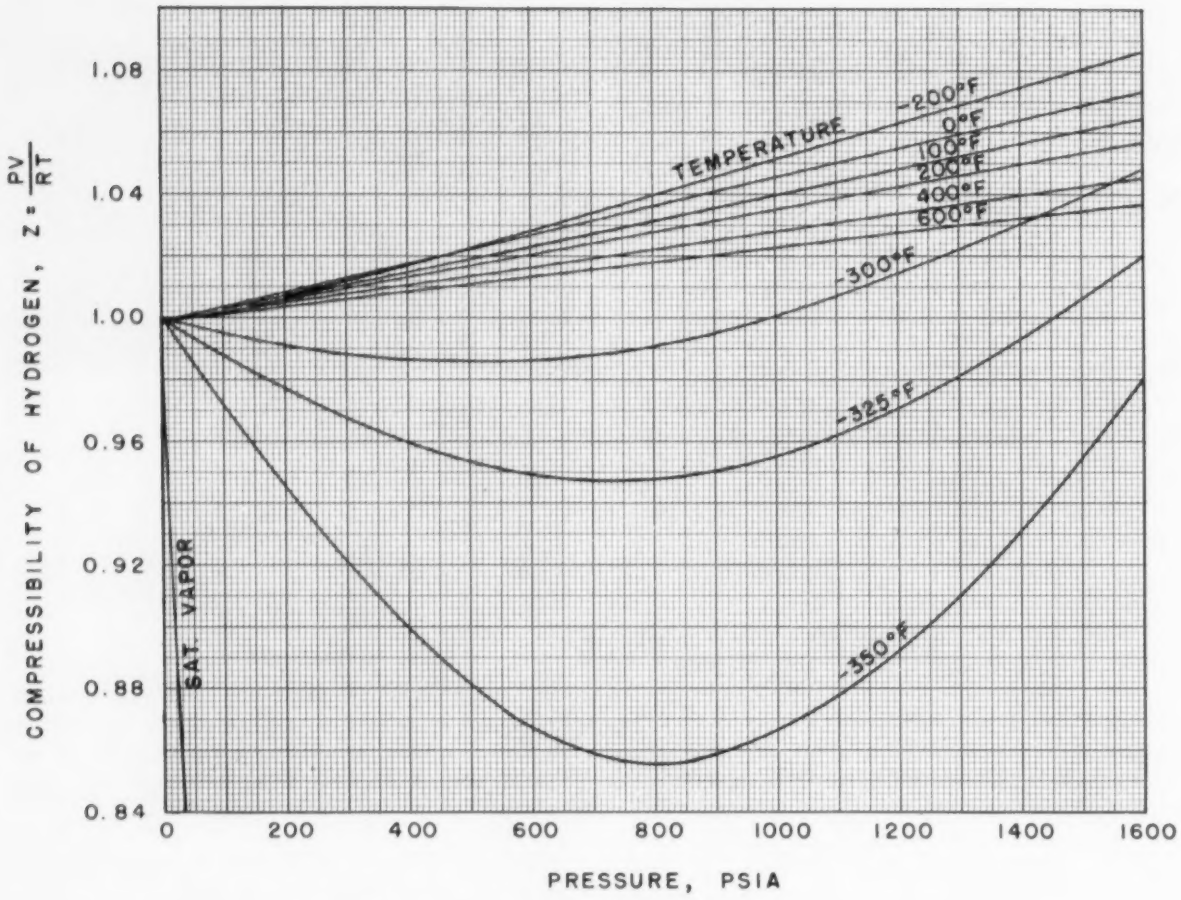


FIGURE 1—Compressibility Factor $Z = \frac{PV}{RT}$ for Hydrogen H_2.

Need Hydrogen Compressibility Fast?

Supplement your PVT data with this compressibility chart.

W. F. Hoot
International Refineries, Inc.
Wrenshall, Minn.

VALUES FOR the compressibility of hydrogen were reported in the comprehensive article on thermal properties of hydrogen by the National Bureau of Standards.[1] These compressibility values were tabulated at various temperatures with parameters of the density in Amagat units. The Amagat density is the ratio of the volume of the gas at standard conditions to its observed volume.

A more recent publication[2] by the National Bureau of Standards tabulates the compressibility factors for hydrogen at various absolute temperatures with parameters of pressure in atmospheres.

Values from these two references are plotted in Figure 1, which gives the compressibility factor versus pressure in pounds per square inch absolute (psia) with parameters of temperature in degrees F. It is hoped this graph will be useful to the design engineer.

LITERATURE CITED

[1] Woolley, H. W.; Scott, R. B.; and Brickwedde, F. G., "Compilation of Thermal Properties of Hydrogen in Its Various Isotopic and Ortho-Para Modifications," J. Research National Bureau of Standards RP 1932, 41, 379 (1948).

[2] Hilsenrath et al, *Tables of Thermal Properties of Gases*, National Bureau of Standards Circular 465 (Nov. 1955).

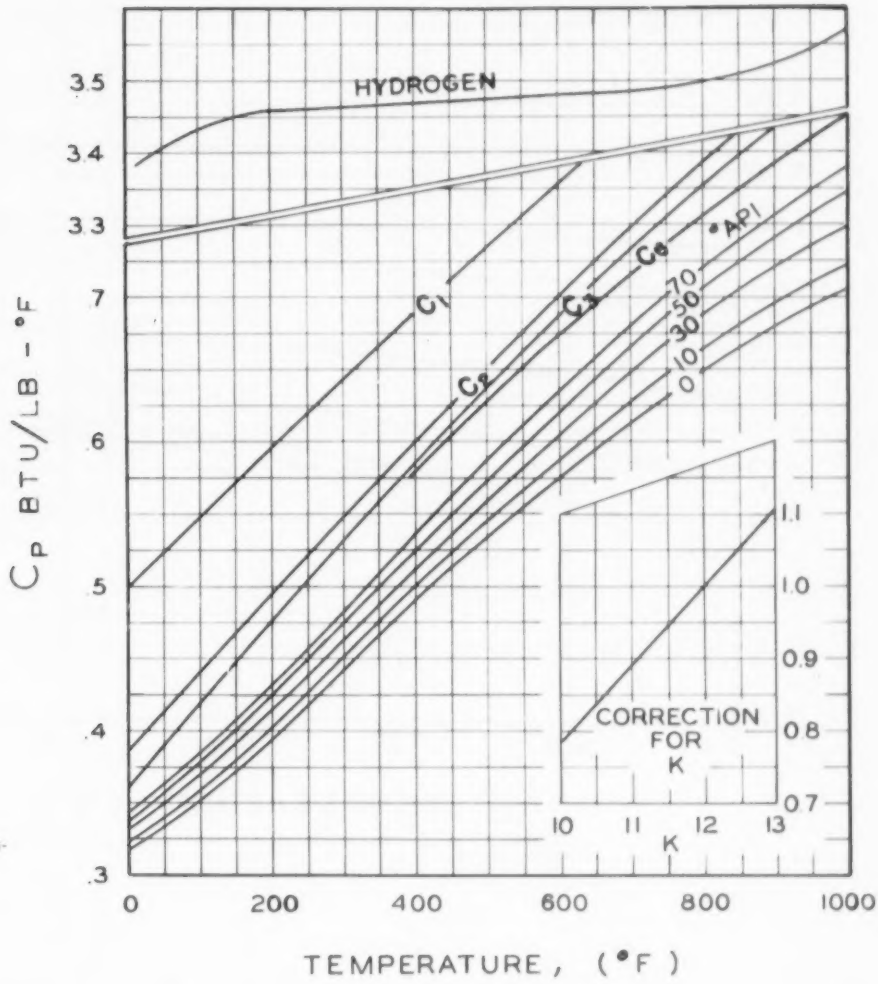


FIGURE 1—Specific Heat at Constant Pressure.

Find Specific Heat Fast

Add this heat capacity chart for hydrogen and hydrocarbons to your file.

W. W. Akers and H. F. Ralph
Rice Institute, Houston

THIS CHART presents the specific heat of hydrogen[3] and hydrocarbon vapors[1,2] as a function of temperature at low pressures. The heat capacity of mixtures can be computed by:

$$Cp_m = X_1Cp_1 + X_2Cp_2 + \cdots\cdots$$
$$= \Sigma X_iCp_i$$

where

Cp_m = specific heat of the mixture
Cp_i = specific heat of component i
X_i = weight fraction of component i in mixture

The effect of pressure on the specific heat of hydrogen is small and the values can normally be neglected for hydrogen-hydrocarbon mixtures at pressures up to 1000 pounds per square inch.

LITERATURE CITED

[1] Holcomb, D. E. and Brown, G. G., Ind. Eng. Chem. 34, 590, 1942
[2] Van Winkle, M., Pet. Ref. 27, 291, 1948
[3] Woolley, H. W., Scott, R. B., Brickwedde, F. G., J. Res. National Bureau of Standards 41, 379, 1948 R. P. 1932.

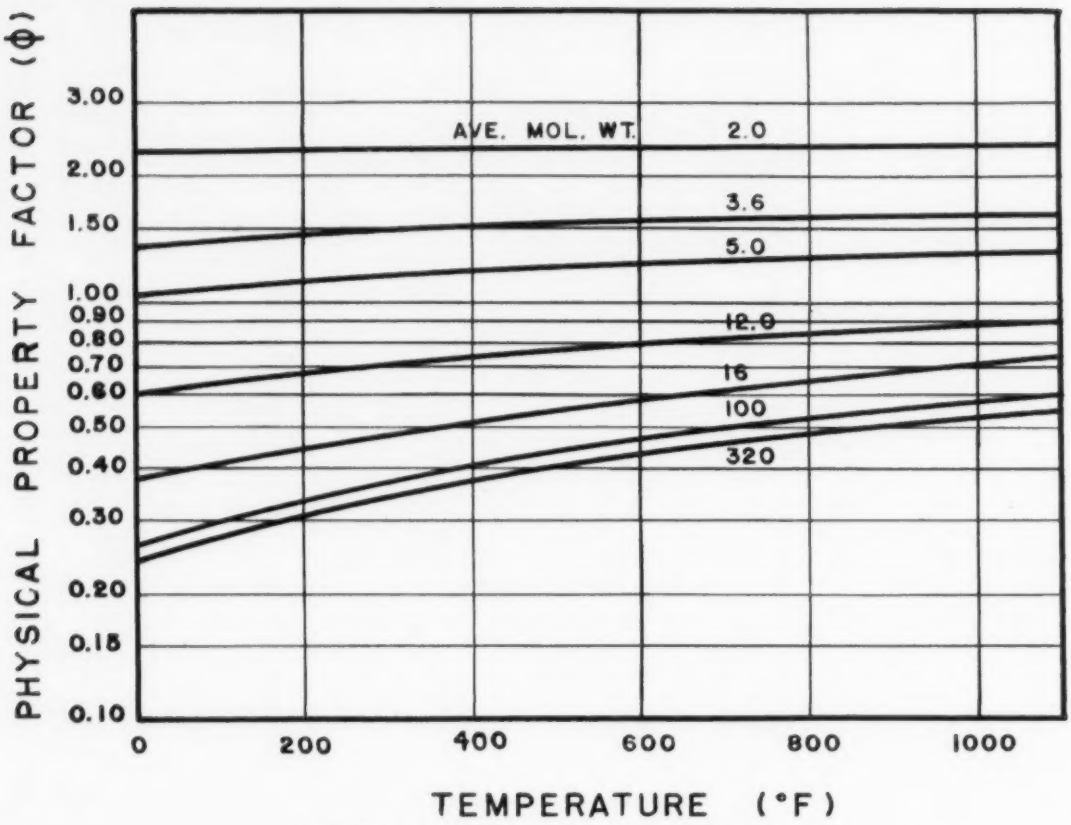


FIGURE 1—Physical Property Factor for Heat Transfer Calculations.

Shorten Heat Transfer Problems

Use this physical property factor to speed design calculations.

W. W. Akers and O. A. Sampson
Rice Institute, Houston

THE HEAT TRANSFER coefficient for the turbulent flow of fluids through tubes can be expressed by the familiar Dittus-Boelter equation

$$\frac{hD}{k} = 0.023\left(\frac{DG}{\mu}\right)^{0.8} \cdot \left(\frac{Cp\mu}{k}\right)^{0.33}$$

This equation can be re-arranged to give

$$h = 0.023 \cdot \left(\frac{G^{0.8}}{D^{0.2}}\right) \cdot \left(\frac{Cp^{0.33}\, k^{.67}}{\mu^{.47}}\right) = 0.023\left(\frac{G^{0.8}}{D^{0.2}}\right) \cdot \phi$$

where G is expressed in pounds of flow per square foot of cross-sectional area per hour and D is the diameter in feet. ϕ represents a physical property factor, dependent upon only the gas, the temperature, and the pressure.

The physical property factor, ϕ, for mixtures of hydrocarbon gases and for hydrocarbon-hydrogen mixtures is presented as a function of average molecular weight and temperature on the above curves. These curves are *not* suitable for other gases, i.e. carbon dioxide, nitrogen, etc.

For flow across tubes, the heat transfer coefficient can be expressed as

$$h = 0.21\frac{G_{max}^{0.6}}{D^{0.4}}\mu^{0.2}\phi$$

where μ is the viscosity expressed as pounds mass/foot hour. G_{max} is the mass velocity at the minimum cross-section.

The physical property factor is only slightly dependent upon the pressure. The curves may be used at pressures up to 1000 pounds per square inch without correction.

##

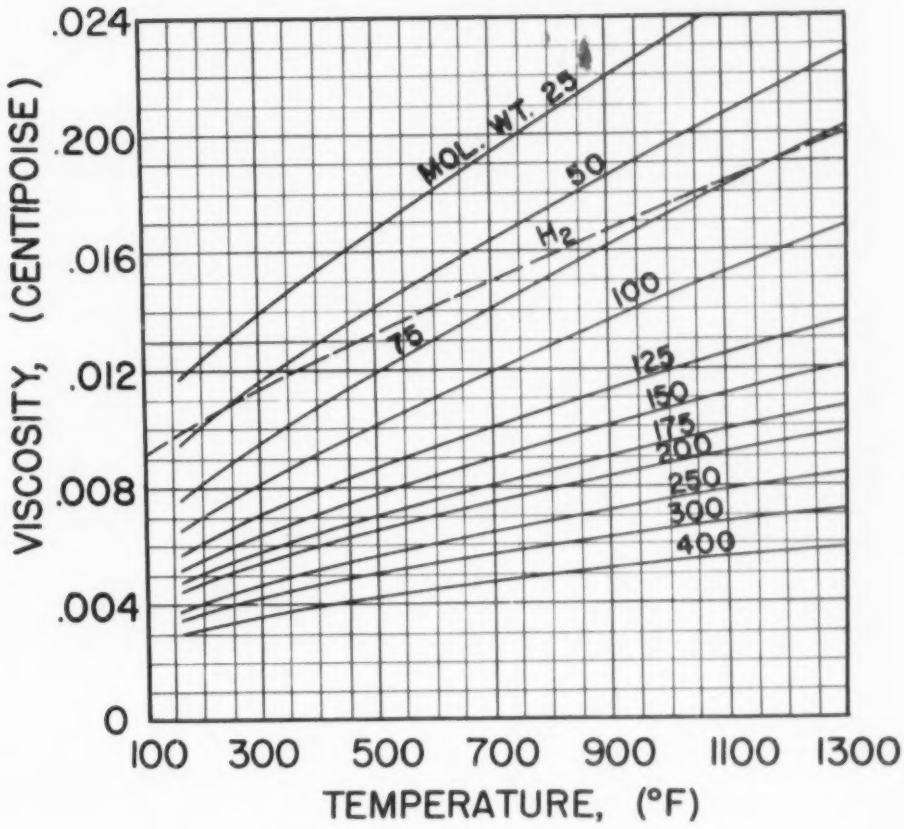


FIGURE 1—Viscosities of Hydrogen-Hydrocarbon Vapors.

Pick Off Viscosity

Use this chart for finding viscosity of hydrogen-hydrocarbon mixtures up to pressures of 1000 psi.

W. W. Akers and R. A. McAllen
Rice Institute, Houston

THESE CURVES present viscosity data for hydrogen vapors of various molecular weights at a pressure of one atmosphere or less. The data for hydrogen were taken from a compilation by Wooley[5] and that for the hydrocarbon vapors from Beale.[1]

The viscosity of a gas mixture can best be represented by the equation:[3]

$$\mu_m = \frac{\mu_1 X_1 \sqrt{M_1} + \mu_2 X_2 \sqrt{M_2} + \cdots\cdots\cdots}{X_1 \sqrt{M_1} + X_2 \sqrt{M_2} + \cdots\cdots\cdots} = \frac{\Sigma \mu_i X_i \sqrt{M_i}}{\Sigma X_i \sqrt{M_i}}$$

where

μ_m = viscosity of the mixture
μ_i = viscosity of component i
X_i = mol fraction of component i
M_i = molecular weight of component i

Pressures up to 1000 pounds per square inch have little effect on the viscosity of hydrogen and slight effect on the viscosity of hydrocarbon gases. Consequently, the effect of pressure on hydrogen—hydrocarbon mixtures can normally be neglected for pressures up to 1000 psi. For higher pressures, the generalized correlations of Comings[2] or Uyehara and Watson[4] may be used.

LITERATURE CITED

[1] Beale, E. S. L., *Science of Petroleum*, Vol. II, 1080, Oxford University Press, New York, 1938.
[2] Comings, E. W. and Egly, R. S., Ind. Eng. Chem. 32, 714, 1940.
[3] Herning L., and Zipperer, L. Gas-u Wasserfach 79, 49 and 69, 1936.
[4] Uyehara, O. A. and Watson, K. M., National Petroleum News, Tech. Sec. 36, R764, 1944.
[5] Wooley, H. W., Scott, R. B., Brickwedde, F. G., J. Res. National Bureau of Standards, 41, 379, 1948, Research Paper No. 1932.

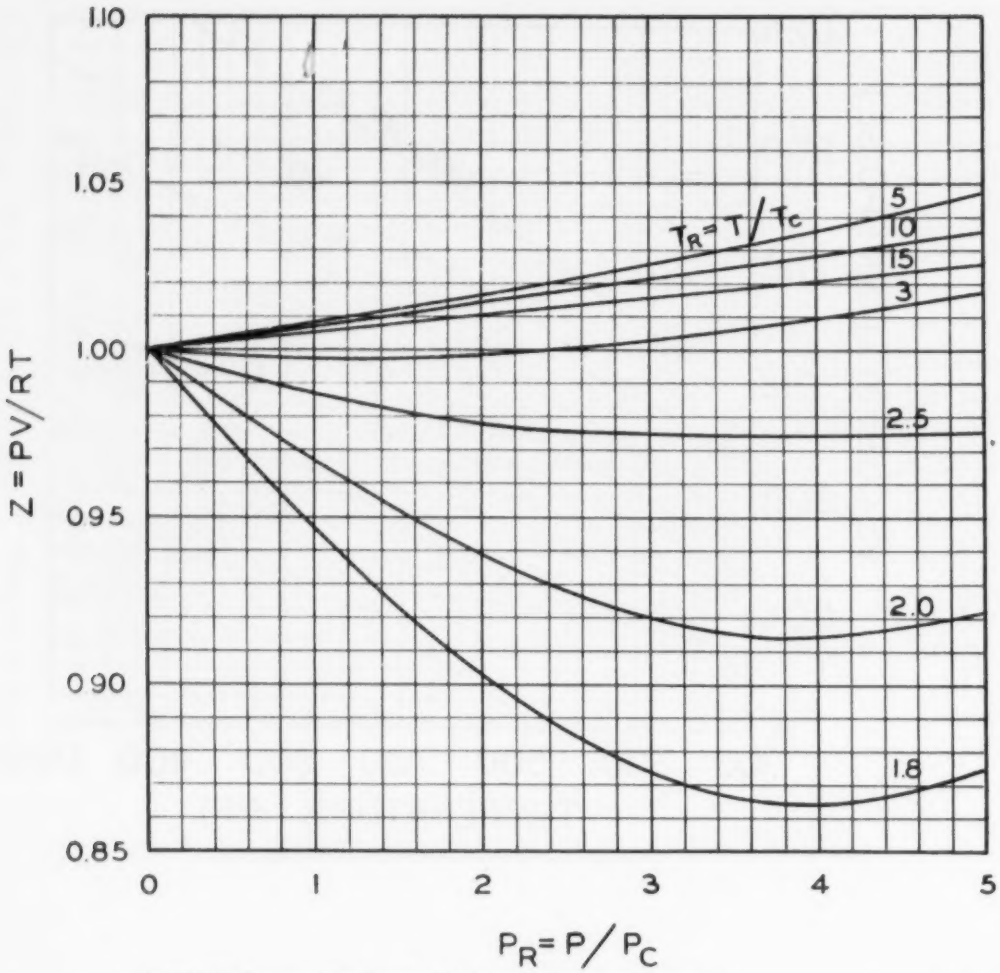


FIGURE 1—Compressibility Factor of Hydrogen-Hydrocarbon Mixtures.

Compressibility Factors of Mixtures

Use this chart with reduced pressures and temperatures to determine the compressibility factor of hydrogen and hydrogen-hydrocarbon mixtures.

W. W. Akers and J. D. Burns
Rice Institute, Houston

THE PLOT PRESENTS the compressibility factor of hydrogen, hydrocarbons, and their mixtures in terms of reduced pressures and reduced temperatures defined by:

$$P_R = \frac{P}{X_1Pc_1 + X_2Pc_2 + \cdots\cdots} = \frac{P}{\Sigma X_1Pc_1}$$

$$T_R = \frac{T}{X_1Tc_1 + X_2Tc_2 + \cdots} = \frac{T}{\Sigma X_1Tc_1}$$

where

P = total pressure
Pc_1 = critical pressure of component 1
T = absolute temperature
Tc_1 = absolute critical temperature of component 1
X_1 = mol fraction of component 1

The true critical temperature of hydrogen (33.19° K and 12.98 atm.) must be used in this correlation.

LITERATURE CITED

[1] Brown, G. G., Souders, M., Smith, R. L., Ind. Eng. Chem. **24**, 513, 1932.
[2] Dodge, B. F., Ind. Eng. Chem. **24**, 1353, 1932.
[3] Newton, R. H., Ind. Eng. Chem. **27**, 302, 1935.
[4] Wooley, H. W., Scott, R. B., Brickwedde, F. G., J. Res. National Bureau of Standards **41**, 379, 1948 R. P. 1932.

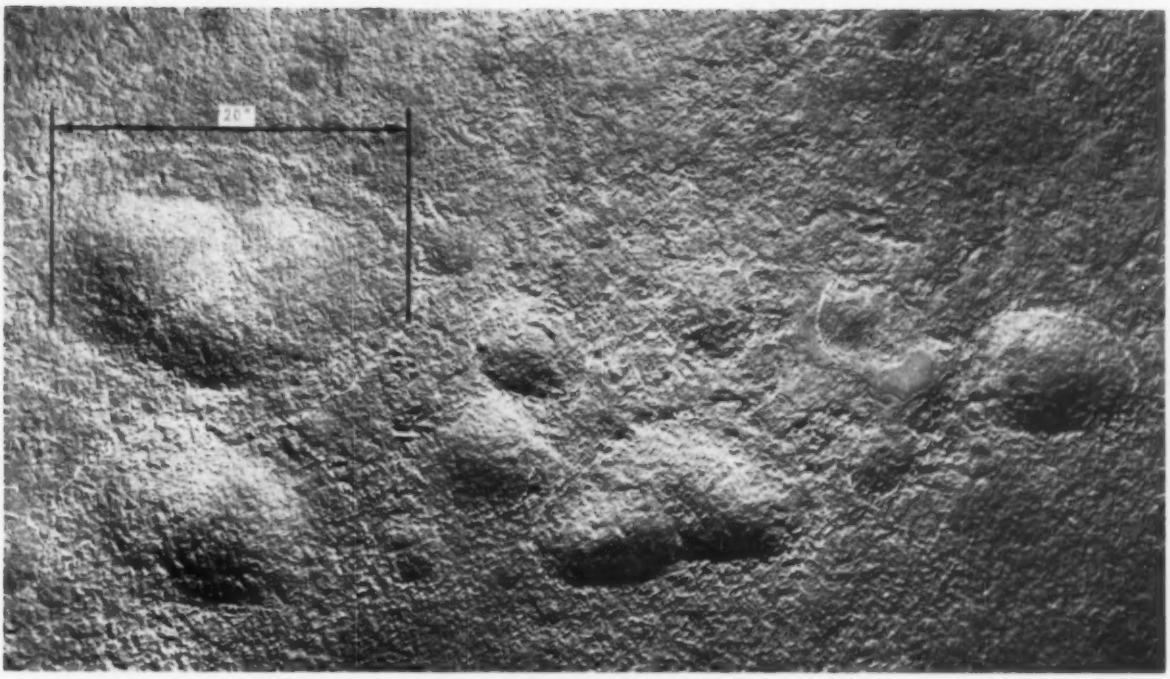


FIGURE 1—Non-cracked blisters.

What Causes Hydrogen Attack?

This article will help you . . .

- **Understand the theory.**
- **Recognize the various forms.**
- **Evaluate the seriousness.**
- **Plan economical maintenance.**

Gordon R. King
Humble Oil & Refining Company, Baytown, Texas

WHAT CAUSES hydrogen attack? Having discovered it in a particular item of equipment, what can be done to attain additional service life?

An article in the January 1956 issue of PETROLEUM REFINER dealt primarily with countermeasures to hydrogen attack by alteration of the process stream. This second article will present briefly the theory of hydrogen attack. In addition, the principle forms of hydrogen deterioration are described and a practical approach to the repair of the damaged area is suggested.

The first prerequisite for hydrogen penetration is, of course, a source of hydrogen. There are several ways in which hydrogen can be evolved in industrial processes by chemical action. In the generation of steam the following reaction is common:

$$3\,Fe + 4\,H_2O \rightarrow Fe_3O_4 + 8\,H$$

Hydrogen sulfide is present in practically all crude oils, therefore, the hydrogen producing reaction found most commonly in the oil industry is:

$$H_2S + Fe \xrightarrow{H_2O} FeS + 2H$$

Atomic hydrogen is thus formed on the surface of the metal which is corroding.

Atomic hydrogen is often liberated as a product of a desired hydrocarbon conversion. In the hydroforming process, methyl cyclohexane, at a high temperature, is contacted with a catalyst. The effect is a dehydrogenation, resulting in methyl benzene and atomic hydrogen.

Formation of Blisters—In the ionized or atomic form, hydrogen has the particular ability to penetrate, quite readily, any thickness of an otherwise impervious steel. At ambient temperature this nascent hydrogen enters the iron lattice of the steel and diffuses through the body of the grain, not the grain boundary, hence it is an intragranular penetration.[25]

In the manufacture of steel plate certain imperfections in the form of laminations, slag inclusions and scale deposits are practically impossible to avoid. Such imperfections were fairly common in boiler plates manufactured a few years ago under ASTM Spec.

What Causes Hydrogen Attack?

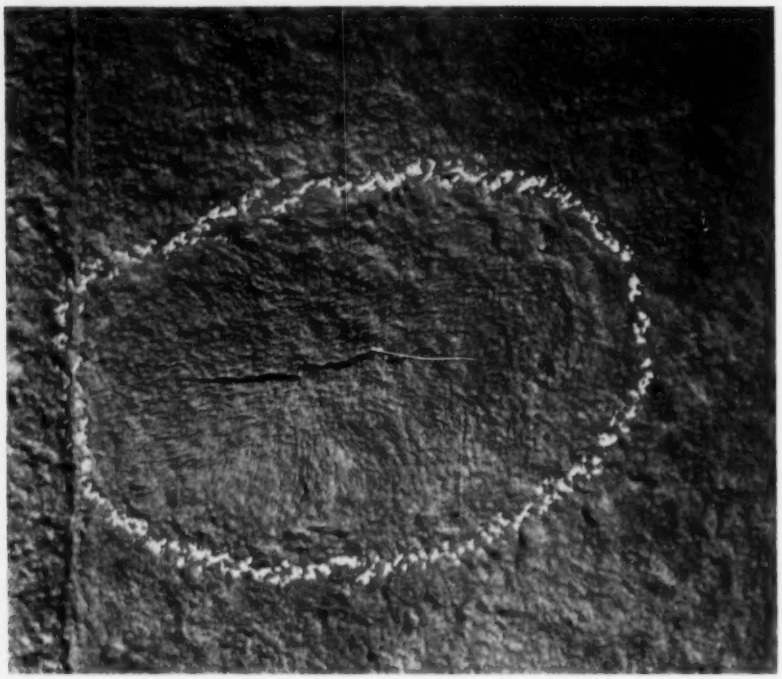


FIGURE 2—Cracked blister.

A-70. Improved steel manufacturing practices and the purchase of boiler plate under the revised ASTM Spec. A-285 has resulted in a much better quality plate, however, some laminations and inclusions still exist. In order for a hydrogen blister to develop there must be an inherent lamination or void in which the hydrogen may collect.

An atom of hydrogen diffuses through the steel and into the void where it collides with another hydrogen atom, forming molecular hydrogen. The ability of the hydrogen atom to penetrate the iron lattice is not shared with the hydrogen molecule, hence the molecule is trapped in the void. This process continues irrespective of the gas or atmospheric pressure on either side of the steel plate.

Higher and higher pressures are built up until the yield point of the material is reached and a blister is born. Pressures as high as 5000 pounds per square inch have been measured in voids where the external pressure was less than 100 pounds per square inch.[25] The size a blister may attain is limited only by the extent of the lamination and the ultimate strength of the material (how ductile or how much embrittlement has occurred).

Hydrogen Embrittlement—High and low temperature hydrogen embrittlement must be considered separately because of certain fundamental differences in the type embrittlement experienced at each condition.

Low temperature hydrogen embrittlement is primarily transcrystalline in character. Atomic hydrogen enters the iron lattice, penetrating the body of the grain and into the multitude of inherent microscopic grain imperfections. Here the hydrogen atoms combine to form insoluble molecular hydrogen. This process continues much in the same manner as in the formation of a blister, building up an internal pressure. When this pressure plus the applied external pressure exceeds the cohesive strength of the steel, cracking occurs.

High temperature hydrogen embrittlement is primarily intercrystalline in character. Here again, atomic hydrogen diffuses through the iron lattice and forms molecular hydrogen within the grain which results in an *intragranular* embrittlement as before. However, at elevated temperatures this condition is secondary to the *intergranular* embrittlement that develops as follows:[25]

1. Atomic hydrogen, entering the grain boundaries, combines with impurities forming insoluble gases. The most prolific reaction is between hydrogen and carbon, forming methane. Other impurities with which hydrogen combines, but to a lesser extent, are: oxygen, sulfur, nitrogen and phosphorus.
2. The depletion of carbon in the steel from the first reaction results in a decarbonized steel, a process which greatly reduces strength.
3. When the pressure of the insoluble gases which are formed in the grain boundaries exceeds the cohesive strength of the steel, minute cleavages occur which allow the escape of the insoluble gases.
4. This relieves the internal pressure in the grain boundaries, hence internal stresses are reduced and some ductility returns.
5. The result is a more pure iron but a considerably weaker steel due to the decarbonized effect.

Accelerators to Hydrogen Penetration—It is well established that the main source of atomic hydrogen in oil refineries is the result of the chemical action between hydrogen sulfide and steel. In this reaction iron sulfide scale is deposited on the corroding surface. If nothing disturbs this scale, sufficient thickness soon is formed to inhibit any further reaction between the hydrogen sulfide and steel and the liberation of hydrogen ceases.

If, however, certain compounds are present in the hydrocarbon stream which react with this protective scale to form a less impervious scale of cause it to dissolve, accelerated hydrogen penetration will result. The rate of hydrogen penetration (up to certain limits) will be proportional to the concentration of this reactive ingredient in a sour hydrocarbon stream.

Cyanide compounds are the most common ingredients found in process oil streams which produce the above described reaction. Cyanides readily react with iron sulfide to form ferrocyanide complexes which no longer protect the metal surface. Cyanides result from nitrogenous compounds produced in catalytic reaction. Nitrogen compounds are found more abundantly in light hydrocarbons produced from the catalytic cracking of heavier crude fractions.

Decelerators to Hydrogen Penetration—The inhibiting effect of ammonia polysulfide compounds to hydrogen sulfide corrosion and hence the penetration of hydrogen was outlined in an article in the January,

FIGURE 3—Fissuring of steel casting.

1956 issue of the PETROLEUM REFINER. A number of other chemical decelerators or inhibitors are known; their chief function being to react with either the hydrogen sulfide or the free hydrogen before it can enter the steel. Among these are sodium chromate, sodium sulfate, and various phosphates, tannates and acetates.

TYPES OF HYDROGEN ATTACK

1. Non-Cracked Blisters—The first form of hydrogen attack to be discussed is known as non-cracked blisters (Figure 1).

Early stage blistering in this category is often very difficult to detect. The metal surface to be examined should be thoroughly cleaned, preferable by sandblasting. Detection may best be accomplished by shining a flashlight parallel to and adjacent the surface and observing the shell from a distance. A shadow from even the smallest blister can be detected thus.

The following conditions must exist before this type attack can result:

1. A source of hydrogen (previously discussed).
2. Inherent discontinuities or laminations within the metal.
3. A ductile material.

The seriousness of blisters which are not cracked, depends upon several factors such as: the number, size, and thickness of the blister; the corrosion allowance of the vessel; and the temperature, pressure and volatility of the medium. It can be stated in general, however, that this type blister is not too serious. It is true that stresses have exceeded the elastic limit of the material and permanent deformation has occurred, but until cracking develops the vessel has lost very little of its original strength. Therefore, immediate repairs are not very often justified. Short inspection intervals or countermeasures to further hydrogen attack should be undertaken to preclude the progression of simple blistering to a more serious damage.

In some instances where the number and size of blisters is great, it may be desirable to drill a small hole in the major blisters to release the internal pressure. This should be done with care to prevent ignition of the escaping hydrogen.

The repair of vessels containing minor blistering; i.e., scattered bulges, small in number and not as yet cracked, can usually be forestalled until a more convenient or economical time. The economical repair of this minor blistering and the large blisters which have been drilled as described above, is the application of a 1-inch to 2-inch layer of reinforce gunite (cement and sand) to all damaged areas. This reduces corrosion of the steel surface, hence decreases the source of atomic hydrogen.

This type liner can be installed for

What Causes Hydrogen Attack?

FIGURE 4—"Ringworm" corrosion.

approximately $1.70 per square foot. In vessels where clearances are limited, alloy liners may be installed. A 14 gage, 18-8 chromium-nickel AISI Type 316 liner will cost approximately $8.50 per square foot. The item of maintenance is a leveling factor between these two types of liners.

2. Cracked Blisters—The second form of hydrogen attack that will be discussed is shown in Figure 2 and is known as cracked blisters.

This condition is much more readily detected than the first form (Figure 1), especially if metal surfaces are clean. The importance of good cleaning prior to an examination where hydrogen activity is suspected cannot be overstressed.

A condition of extensive fissured blistering should be viewed with considerably more concern than blistering described in the first form because of such unknown factors as:

1. How far beyond the blisters and into the adjacent shell do the cracks extend? In a shell where hundreds of blisters exist, determination of this factor becomes impractical.
2. How deep are the blisters and how much effective shell thickness remains? This factor is important if an evaluation of the allowable working pressure is to be made.

In view of these other indeterminate factors, immediate repairs or replacements should be considered. If the total number of defects is small, temporary repairs may be performed by chipping or grinding out the cracks and welding these areas. Unless there is assurance that further hydrogen attack will be abated, the replacement of the vessel or section of the vessel in which these protuberances occurred should be accomplished at the earliest possible date. It can be concluded that the remainder of this shell section is likewise laminated and further blistering and cracking can be expected.

3. Fissuring of Steel Castings—Figure 3 illustrates still a third form of hydrogen attack—fissuring of steel castings.

It is characterized by a multitude of check cracks, which in the later stages join to form dangerous continuous cracks. Note the nearly continuous circumferential crack just inside the outlet nozzle of this cast steel pump case.

The existence of this type attack is contingent upon the basic elements previously outlined; i.e., a source of hydrogen, an accelerator, and an inclusion or lamination. The inclusion in this case are minute sand holes or air pockets within the casting in which molecular hydrogen forms, building high pressures. This is an additive force to whatever interlattice embrittlement occurs. These forces result in the illustrated type cracking.

The decision to repair or replace damaged castings depends upon the severity of cracking plus the physical operating factors. The pump case in Figure 3 was given temporary repairs and was replaced as soon as a new case could be received. Generally, repairs are fairly easy to make by chipping, or grinding, and welding. Accessibility and extent of cracking are usually limiting factors to the repair of these castings.

4. Ringworm Corrosion—A fourth form of hydrogen attack is known as ringworm corrosion (Figure 4).

Ringworm corrosion is a very distinctive type hydrogen attack. Cleaning by sandblasting is necessary if this condition is to be detected. This particular pattern is the result of a combination shallow hydrogen blistering plus a chemical corrosion. The inclusion in this case was caused by mill scale or other foreign material being rolled into the surface of the metal.

The progression of events in this attack were:

1. A corrosive medium attacked the steel releasing atomic hydrogen.
2. The hydrogen penetrated into the shallow lamination, formed molecular hydrogen and started building pressure.
3. As the tendency toward the formation of small shallow blisters progressed, stresses at the circumferential boundary of these blisters increased.
4. Stress corrosion then resulted in greater metal loss at these areas of higher stress than at surrounding areas.

The effect was to leave small "islands" which could no longer become hydrogen blisters because the seal was broken. Substantiating this theory, these small "islands" may easily be removed by a light blow from a chisel, revealing a definite inherent lamination between the "island" and the parent metal.

In later stages of this attack, after corrosion has resulted in a more general loss of metal, these "islands" are washed away in the stream and the surface takes on a pitted appearance. Therefore, in many cases where extensive pitting is experienced, it is actually a result of this "cleaning-up" action of surface dirty steel plate.

A vessel with this ringworm corrosion can be treated in the same manner as one which has been corroded to

the same depth as the bottom of these islands. In general, this type hydrogen attack is significant only as a matter of interest, for the depth of such islands rarely exceeds an eighth of an inch.

5. Embrittlement—The type of hydrogen attack shown in Figure 5 shows embrittlement resulting in the cracking of the welds.

The condition illustrated in Figure 5 is common where hydrogen activity is prevalent. Note the radical cracks extending across the face of the weld and the numerous circular holes in the weld. The cracking is simply the result of intragranular embrittlement, previously discussed, and is following the normal stress pattern. The small circular holes are the result of small near-surface welding rod flux inclusions enlarged by stress corrosion.

In all cases the cracks should be removed and the areas rewelded if necessary. Normally these cracks will be shallow. However, they have on occasions, extended completely through the weld, resulting in a leak.

6. Damage to Paint—Figure 6 illustrates the damage to paint that can result from hydrogen activity. The vessel pictured had no appreciable hydrogen blistering of the steel shell, but had a high internal corrosion rate due to the presence of hydrogen sulfide and moisture. The lack of shell blistering bears out the point that inherent laminations or inclusions are a necessary prerequisite to this phenomenon.

The vessel in Figure 6 had recently been painted and the paint, therefore, acted as a flexible membrane. The atomic hydrogen released on the inner surface of the shell as a product of corrosion, passed through the shell and combined to form molecular hydrogen between the shell and the paint membrane. A sample of the entrapped gas was analyzed in the mass spectrometer to verify this theory.

The following results were obtained:

Compound	Mol. per cent of total
Nitrogen	11.5
Hydrogen	88.0
Propane	0.1
Iso-butane	0.2
Total butylenes	0.2

A short time after the photograph was taken, the paint blisters ruptured leaving unprotected areas of the shell as large as three inches in diameter. This tower was painted several times after the occurrence of these blisters and no blistering developed. These later paintings were allowed to dry before the unit was put into service. Apparently the paint no longer acts as a flexible membrane after drying.

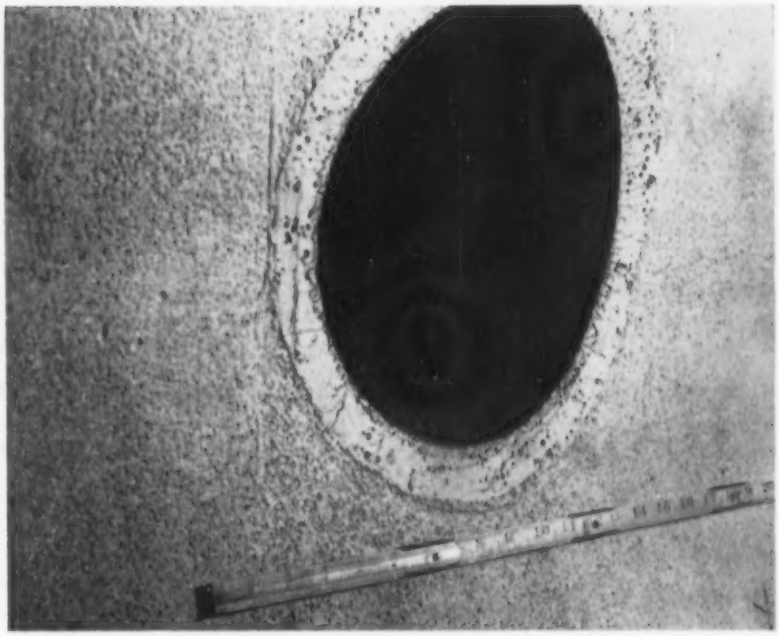


FIGURE 5—Embrittlement and cracking of welds.

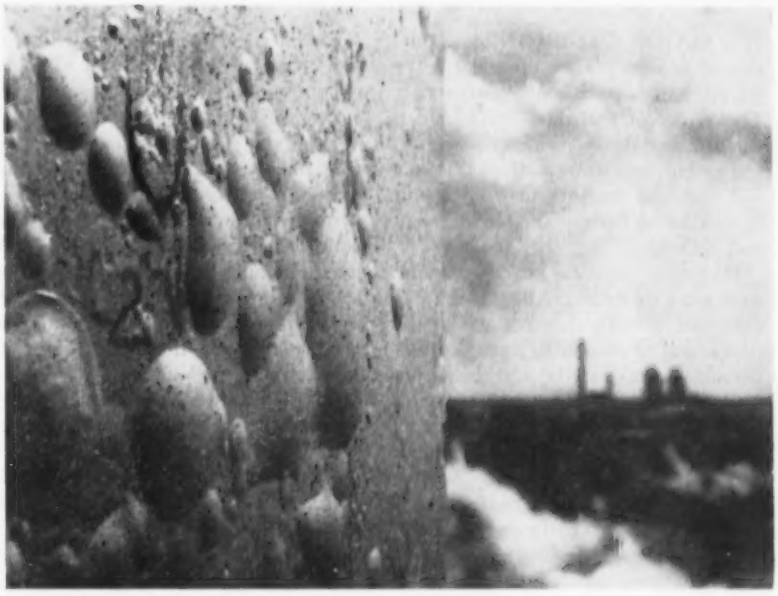


FIGURE 6—Paint blistering due to hydrogen passing through steel vessel.

Conclusions—The problem of hydrogen attack can be approached in two general ways, by altering conditions which cause the phenomenon or by "living" with it, i.e., recognizing the seriousness of each form of attack and evaluating the most economical maintenance program for the particular case.

ACKNOWLEDGMENT

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LITERATURE CITED

For 32 references dealing with hydrogen attack see *Petroleum Refiner*, Vol. 35, No. 1, January, 1956, p. 128.

[9] "Boiler Embrittlement"—Zapffe, C. A.—Trans. ASME 66 Pg. 81-126 (1944).

What Hydrogen Does to Metals

• Lowered ductility . . . easily detected by bend test or by elongation and reduction of area tensile tests.

• Lower tensile tests . . . dependent upon the degree of hydrogen embrittlement but failure occurs at different points on same stress-strain curve.

• Hardness . . . is not affected by hydrogen embrittlement for most metals.

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A MAJOR DECISION in the design of process plant equipment is the selection of materials of construction. The effect of hydrogen on many of these materials makes this decision of increasing importance. This article will appraise the present state of our knowledge of hydrogen embrittlement and attack.

Hydrogen may be introduced into steel after its manufacture. It may be absorbed directly from a gas phase containing hydrogen as a major component. It also may be absorbed from nascent hydrogen generated by chemical or electrolytic action at the metal surface. Whatever its source, its effect is likely to be detrimental, and to result in steel with lowered ductility.

The action of hydrogen on steel and other metals has two distinct manifestations—hydrogen embrittlement and hydrogen attack.

Hydrogen embrittlement of steels has been recognized for many years to result from the presence of hydrogen *per se* within the metal. This effect has been observed primarily at room temperature, and may be caused by:

- Hydrogen dissolved in steel during the course of its manufacture.
- Hydrogen generated by chemical action as in acid pickling.
- Hydrogen generated by electrolytic action as in electroplating.

Recent developments show that it also results from the action of high-pressure hydrogen gas at room temperature.[1, 2, 3]

Hydrogen attack is a high-temperature phenomenon caused by the formation of methane by the reaction of hydrogen and carbon in the steel. This action results in decarburization of the steel and intergranular cracking caused by the pressure of methane, which collects primarily at the grain boundaries. Hydrogen attack has been observed primarily as a result of the action of high-temperature, high-pressure gases containing appreciable amounts of hydrogen. It was first observed in connection with the Haber process for the synthesis of ammonia, and has been studied extensively.[2, 3, 4, 5, 6]

The problems of hydrogen embrittlement and attack have become increasingly important in the petroleum and petrochemical industries. Technological advances during the last decade resulted in the commercial development of many new processes. Some of these employ conditions which promote hydrogen embrittlement or attack.

A well-documented example[7, 8, 9, 10] is the severe hydrogen embrittlement problem encountered with catalytically cracked gas streams. This embrittlement results from corrosion by hydrogen sulfide in aqueous solution. This problem apparently has been solved in a most satisfactory way.[10] Other problems remain; still others are yet to be recognized. The use of ever higher pressures in the petrochemical industry will lead to problems of embrittlement or attack where hydrogen is present.

Examples of processes already making use of high hydrogen pressures are those employing synethsis gas ($CO + H_2$) for the production of alcohols and other chemicals, the synthesis of ammonia, and various high-pressure hydrogenation processes. Previously it was thought high temperatures were necessary to produce hydrogen damage from the high-pressure gas. However, it is now known that damage can result at room temperature if the pressure is sufficiently high, the damage being embrittlement rather than attack.

Hydrogen Embrittlement—The effects of hydrogen on steel and other metals resulting from hydrogen embrittlement must be considered separately from hydrogen attack. The exact mechanism by which hydrogen embrittlement occurs has not yet been conclusively demonstrated. It is generally accepted that embrittlement is caused by the collection of hydrogen in "rifts" or "voids" or other lattice imperfections which are thought to exist in metal crystals. Much evidence is available to support this supposition.

It is known that the true solubility of hydrogen in iron is extremely small at room temperature and atmospheric pressure. Iron can be made to "occlude" or hold rather large volumes of hydrogen under these conditions by cathodic charging or by acid attack. Such occluded hydrogen might be thought to collect at grain boundaries, but failure of hydrogen embrittled metal occurs transgranularly rather than intergranularly.

Important empirical observations in connection with embrittlement of steels and certain other metals by hydrogen are:

1. The source of hydrogen is immaterial for those metals which are subject to embrittlement at room temperature. Embrittlement results to the same extent from hydrogen introduced by: electrolysis; chemical action which releases nascent hydrogen; or by exposure to hydrogen gas at high pressure and/or temperature.

2. The results of hydrogen embrittlement are:

- Lowered ductility as measured by a bend test or by elongation and reduction of area in tensile tests.
- No change in shape of the stress-strain curve of the normal tensile test.
- During tensile tests, failure occurs at considerably lowered values of strain, depending on the degree of embrittlement, i.e., failure occurs at different points on the same stress-strain curve.
- No effect on hardness of the metal.

3. Embrittlement may be correlated with hydrogen content. Ductility decreases with increasing hydrogen content up to a critical point. Increasing hydrogen content, past this critical point, has no effect on ductility.

4. The degree of embrittlement as shown by the tensile or bend test is dependent on the temperature of testing and the rate of strain employed in the test.[11] At high strain rates the effect of hydrogen on ductility disappears.

Hydrogen embrittlement is not detectable by impact tests where strain rates are very high. At low rates of strain, hydrogen embrittlement vanishes at both high and low temperatures, i.e., well above or below room temperature.

Data indicate that for AISI 1020 steel hydrogen embrittlement does not occur at temperatures above about 400 F. Experience with hydrogenation plant equipment indicates that hydrogen embrittlement is not a problem at high temperatures.[12] However, hydrogen diffuses more rapidly through steel and other metals at high temperatures, and hydrogen content of the metal is likely to be high under such conditions. Hydrogen attack, a high-temperature phenomenon, must be prevented by one means or another.

The rate of cooling during shutdown must be slow to allow the hydrogen time to diffuse out of the metal. Fast cooling may cause damage due to hydrogen embrittlement.

5. No systematic correlation between susceptibility to hydrogen embrittlement and carbon or alloy content of steel has yet been discovered. All steels seem to be subject to hydrogen embrittlement, to some degree, except the austenitic steels, e.g., 18-8 stainless. Samples are occasionally found which seem not to be embrittled by hydrogen, but they cannot be explained on the basis of alloy content.

Certain metals, such as copper and its alloys and aluminum are apparently not embrittled by hydrogen at room temperature. Alloys of iron, nickel, chromium, and cobalt seem all to be susceptible unless they are austenitic. The austenitic structure is practically immune to serious hydrogen embrittlement according to all tests so far reported[2,13] regardless of composition.

6. The history of the metal seems to exert a profound influence over the degree of susceptibility to hydrogen embrittlement. Fully "killed" steels are less susceptible than "rimmed" steels. Cold rolling may greatly increase susceptibility.

Hardened steels seem much more seriously embrittled than annealed steels, although tempering at a high temperature reduces the effect. It appears likely that a fully "killed" steel which is hot rolled and fully annealed should have at least high residual ductility after charging with hydrogen.

7. "Embrittlement," as used here, describes only the effect of hydrogen at room temperature in lowering the ductility of metal without the formation of any microscopically visible cracks or changes in structure. Such embrittlement is reversible in that the ductility of an embrittled sample may be restored by aging either at room temperature or much more rapidly at elevated temperatures. During the aging process, hydrogen diffuses from the metal, and leaves no permanent effect in the metal.

Embrittlement may, however, be accompanied by cracking if stresses are present in the metal or by fissuring and blistering if voids large enough to accommodate molecular hydrogen are present. Such voids are most often present in "dirty" steels and "unkilled" steels and sometimes in welds.

Hydrogen atoms diffusing through the metal collect in voids, and recombine to form molecular hydrogen. The gas formed exerts extremely high pressures in the void spaces. When the yield point of the metal is exceeded, local rupturing occurs, and fissures or blisters form to damage the metal permanently.

8. All undesirable effects of hydrogen embrittlement cannot be detected by tensile and bend tests, particularly on hardened steels. Delayed failure may occur in stress-rupture tests at very low stress levels in high-strength steels that have been embrittled by hydrogen.[14] This effect is associated with the greatly increased sensitivity of embrittled steels to stress raisers such as notches.

For example, if a steel such as AISI 4340 is heat treated to a nominal tensile strength of 230,000 pounds per square inch and then moderately charged with hydrogen, failure of a sharpnotched tensile specimen in the common tensile test occurs at a stress level of from 220,000 to 300,000 psi. However, if identical specimens are subjected to a continuous static load they fail at stresses of from 50,000 to 120,000 psi after about seven hours.

For each material tested there was a critical stress below which failure did not occur in any time up to 250 hours. Since stress raisers are unavoidable in practice, the stress-rupture test of notched specimens might

well be adopted as the standard for evaluating the effect of hydrogen embrittlement.

Preventive Measures—The source of hydrogen determines the measures required to prevent embrittlement. Two sources important in petroleum and petrochemical industries are nascent hydrogen generated at the metal surface by chemical action and high-pressure gas streams containing high percentages of hydrogen. Only the former source seems to be of importance at the present time.

Hydrogen embrittlement has been observed where hydrogen sulfide is present in an aqueous phase, especially in the presence of cyanides. Difficulty has also been experienced where sulfuric acid is used and in hydrogen fluoride alkylation plants. In each case the source of hydrogen is a chemical reaction which results in a corrosive attack at the metal surface and which releases atomic hydrogen. The sulfide attack can be represented by the reaction:

$$Fe + H_2S\ (aq) = FeS + 2H$$

Embrittlement caused by corrosive attack can be prevented by several means. A metal can be used which is not subject to corrosive attack. This is likely to be an expensive solution to the problem; however, the use of clad steels might be attractive. Austenitic stainless steels, which are not subject to embrittlement can be employed, but again the expense is great.

A more promising solution is the addition of agents to the process stream which render it non-corrosive or which protect the metal from corrosion in one way or another. This is the solution which has been successfully applied to control embrittlement from aqueous hydrogen sulfide attack.[10]

The addition of small quantities of oxygen (or air) to the process stream together with sufficient quantities of ammonia to maintain the pH above 7.8 results in the formation of a thin film of iron polysulfide on the steel surfaces which protects them against further corrosion.

Embrittlement from hydrogen gas at high pressures and ambient temperatures is likely to be encountered as process pressures are raised. This source of hydrogen as an embrittling environment has only recently been recognized in laboratory investigations,[1,2,3] but hydrogen at less than 500 atmospheres can produce serious embrittlement. High pressures develop high-stress levels and require high-strength steels. Both of these factors appear to augment hydrogen embrittlement and could cause failure of conservatively designed equipment.

It is possible that this problem can be solved by introducing a small amount of a material which would "poison" the metal surface to the adsorption of atomic hydrogen, but no such material is known at present. Such a material might also poison metallic catalysts, and so its use would be ruled out.

The use of liner materials, that are not embrittled, is another solution to this problem. The use of metallic liners —austenitic stainless steel, copper, or aluminum—will not prevent hydrogen diffusion. These liners must be vented to prevent embrittlement of the outer layers of steel. The use of laminated vessels is particularly attractive for this application.

Hydrogen Attack—Hydrogen attack is a high-temperature phenomenon. It can cause the virtual disintegration of certain types of steel and other metals. It results from the exposure of such metals to hydrogen gas at high temperatures and pressures. If the temperature is sufficiently high, e.g., 1000 F, attack can be caused by hydrogen at one atmosphere. Below 400 F hydrogen attack is unlikely at any pressure.

There is no reason why hydrogen attack could not result at high temperature from the same kind of corrosive environments which produce hydrogen embrittlement at low temperatures. Conditions encountered in reforming, hydrogenation, ammonia synthesis and other synthesis processes are capable of producing hydrogen attack.

Hydrogen attack is quite different from hydrogen embrittlement. It usually renders steel brittle, but this is but one result of the general deterioration caused by high-temperature hydrogen. Attack is also dependent on the diffusion of hydrogen into the metal, but this is only a preliminary step. The mere presence of hydrogen may cause embrittlement but not attack. Attack depends on chemical reaction between hydrogen and carbon to form methane, at least in steels.

Attack appears to result from the reaction of hydrogen and oxygen to form water in copper, copper alloys and certain other metals. Completely deoxidized copper is not subject to attack. Rate of attack is controlled by chemical reaction, therefore, temperature, pressure, time and metal composition are important variables.

At high temperatures hydrogen diffuses readily through most metals and has little tendency to accumulate in voids and cause embrittlement. It may react with carbon in steel to form methane which does not readily diffuse because of its greater molecular size. This methane collects at voids and grain boundaries, building up pressure to cause intergranular cracking, fissuring and blistering. Decarburization also results, and the usual effect of attack is to reduce hardness, ductility and tensile strength. The stress-strain diagram of the common tensile test is also altered. This damage to steel is usually evident from microscopic examination.

Figure 1 shows a photomicrograph of a low-alloy steel (0.5C, 0.65Cr, 0.18Mo) after exposure to hydrogen

Meet the Author

HENDRICK C. VAN NESS, who teaches a graduate course for chemical engineering students at Purdue University, has been an assistant professor at the university since 1952. Previously associated with The M. W. Kellogg Company, Dr. Van Ness entered Yale University to begin studying for his doctorate in 1949. While at Yale he held an AEC fellowship for two years, working on the effects of hydrogen on metals at high pressures. Dr. Van Ness first started teaching a this Alma Mater, the University of Rochester, where he completed his master's degree in chemical engineering while serving as an instructor in engineering. He is a licensed engineer in New York.

at about 1000 atm and 800 F for 1 week. The sample was polished but not etched, and is shown at a magnification of 25X. The dark lines are cracks.

The susceptibility of steel to hydrogen attack is related to the composition of the steel. Since attack depends on the availability of carbon to react with hydrogen, the use of alloying elements which tie up the carbon in the form of very stable carbides should render steel resistant to attack. It has been found that the addition of alloying elements such as titanium and vanadium, which form very stable carbides, are particularly beneficial in promoting resistance to hydrogen attack. Sufficient quantities must be used to tie up all the carbon as a stable carbide. The weight ratio of vanadium to carbon should exceed 5.7 and for titanium the weight ratio Ti/C should exceed 4. Keeping the carbon content low avoids large alloy requirements.

Chromium and molybdenum are increasingly beneficial as their alloy content is increased. Much higher alloy contents are required than with titanium or vanadium. Additions of silicon, nickel, or copper are not helpful. The austenitic stainless steels seem to be practically immune to hydrogen attack, just as they are to hydrogen embrittlement.

Certain nickel-base alloys cannot be recommended on the basis of recent tests.[2] These materials do not seem to suffer the same type of attack as steels. Nevertheless their mechanical properties are severely affected by exposure to high-temperature, high-pressure hydrogen. Possibly attack in these cases involves the reaction of hydrogen with oxygen to form water vapor, or they may be simply embrittled at high temperature. In any event, metals for service under conditions favorable to hydrogen attack should be fully "killed" or deoxidized.

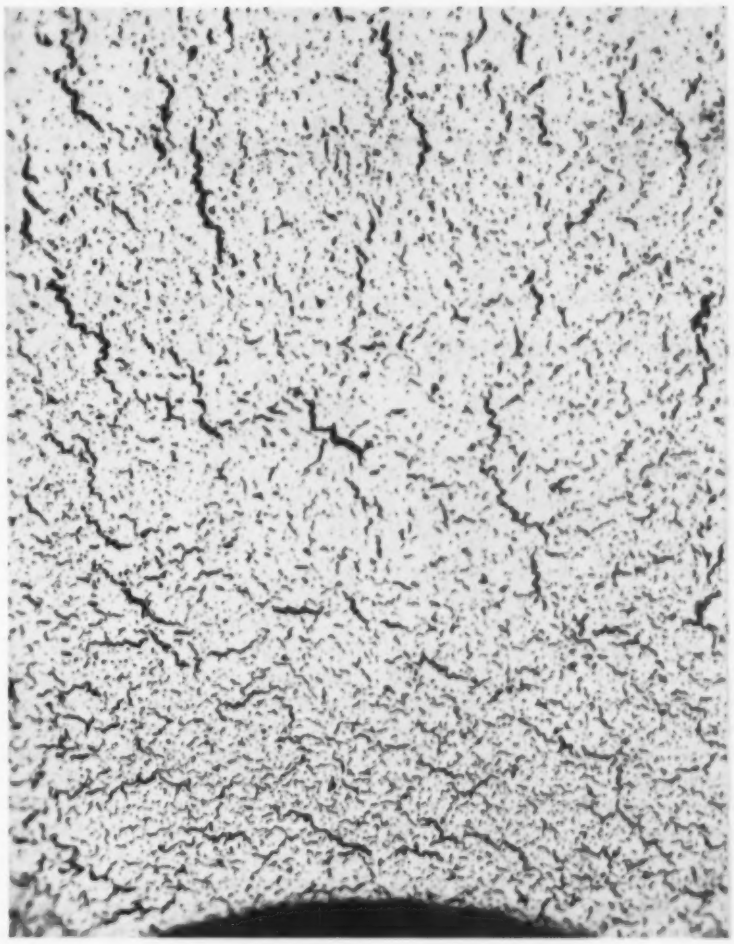

FIGURE 1—Decarburization caused by hydrogen reacting with carbon.

Prevention of Hydrogen Attack—There are several means of guarding against high-temperature and high-pressure hydrogen attack. Alloy steels not subject to attack at the service conditions can be used. In the past chromium-molybdenum steels,[12] with up to 6 percent Cr and 0.5 percent Mo, have been used for such service at high temperatures. Low alloy titanium or vanadium steels might serve the purpose even better.

Hydrogen diffusion is not prevented by the use of these steels. Low rates of cooling on shutdown should still be used to permit hydrogen to diffuse from the metal. This will prevent damage at room temperature from hydrogen embrittlement.

Liners of resistant metal, such as titanium, vanadium or chromium steels or austenitic stainless steels, within a carbon steel shell may also be used. Such liners must be vented, however, to prevent hydrogen attack of the outer shell. The use of bonded or clad liners is therefore ruled out.

Keeping the metal shell temperature low enough to prevent hydrogen attack is another procedure used. This may be done by using an inner lining of refractory material and insulation to reduce heat transfer to the metal shell. Here cooling rates should also be kept low because there is no known method of preventing hydrogen diffusion.

LITERATURE CITED

[1] Anonymous, Chem. Eng. News, 30, 2942 (1952).

[2] Van Ness, H. C., and B. F. Dodge, Chem. Eng. Progr., 51, 266 (1955).

[3] Perlmutter, D. D., and B. F. Dodge, "Effects of Hydrogen at High Pressures on the Mechanical Properties of Metals" at 128th National Meeting, American Chemical Society, Minneapolis, Sept. 12, 1955.

[4] Schuyten, J., Corrosion and Materials Protection, 4, No. 5, 13 (J. of Corrosion Section) (1947).

[5] Ibrig, H. K., Ind. Eng. Chem., 41, 2516 (1949).

[6] Nelson, G. A., Trans. Am. Soc. Mech. Engrs., 66, 81 (1944).

[7] Effinger, R. T., M. L. Ranquist, A. G. Wachter, and J. G. Wilson, Petroleum Refiner, 30, No. 5, 132 (May, 1951).

[8] Skei, T., A. Wachter, W. A. Bonner, and H. D. Burnham, Corrosion, 9, No. 5, 163 (May, 1953).

[9] Bonner, W. A., H. D. Burnham, J. J. Conradi, and T. Skei, Petroleum Processing, 8, 686, 878 (1953).

[10] Bonner, W. A., and H. D. Burnham, Corrosion, 11, 447t (1955).

[11] Brown, J. T., and W. M. Baldwin, Jr., J. Metals, 6, 298, 1327 (1955).

[12] Nelson, G. A., and R. T. Effinger, The Welding Journal, 34, No. 1, 12s (Jan., 1955).

[13] Hobson, J. D., and J. Hewitt, J. Iron Steel Inst., 173, 131 (1953).

[14] Frohnberg, R. P., W. J. Barnett, and A. R. Troiano, Trans. Am. Soc. Metals, 47, 892 (1955).

M-O-C* for Hydrogen

***Materials-of-construction prevent hydrogen decarburization, blistering and cracking by use of proper alloys and steels.**

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ONCE HYDROGEN, in the atomic form, has entered a metal it is capable of doing serious damage. Suitable liners can prevent the entrance of hydrogen into the metal.

If hydrogen must be tolerated in the metal the carbon must be protected by alloying it with carbide formers. This is particularly important when operating temperatures exceed 500 F. Soundness of metal and low order stresses offer protection against blistering and cracking at lower temperatures. In this case also a liner would offer the greatest protection.

Special alloys and steels must be employed in the manufacture and use of hydrogen. Not only can hydrogen alone be destructive to some steels but the compounds of hydrogen and other reagents acting in the presence of hydrogen can produce unusual forms of destruction.

Hydrogen is produced commercially by releasing it from a hydrocarbon (steam-methane reforming) or by partial oxidation of the hydrocarbon in an atmosphere of concentrated oxygen.

The formation of hydrogen by steam-methane reforming over a nickel catalyst is endothermic. The reaction requires a temperature level of 1600-1800 F. The wall temperature of the containing vessel, usually tubes, must operate with a wall temperature of 1700-1900 F. The tube material must be highly resistant to both the oxidizing effects of steam on the inside and the flue gases on the outside. High order resistance to stress-rupture is also desirable in the tube metal.

The chromium-nickel or nickel-chromium heat resisting alloys provide the best combination to date of oxidation resistance and resistance to stress-rupture. A minimum of 45 percent chromium-nickel with at least 12 percent chromium must be present to resist oxidation for long periods at 1800 F. and above.

The required amounts of chromium and nickel give the large grain form of austenite typical of these alloys. These large grains give the best resistance to creep or stress-rupture. It is better to grow the grains to a maximum size by heating the tube materials to about 2000-2100 F. This treatment also assures solution of practically all constituents into the austenite. The rapid cooling prevents precipitation of carbides or other constituents.

The most commonly used heat resisting alloys for tubes in hydrogen producing units are the Type 310 stainless steels (25 percent chromium, 20 percent nickel), chrome-nickel steels (35 percent nickel, 20 percent chromium) and high nickel steels (79 percent nickel, 15 percent chromium).

The last two alloys are largely furnished as extruded tubes while Type 310 is generally furnished as a pierced tube or as one welded from strip. Seamless tubes are used for high pressure operation and are usually small diameter to reduce stresses. Large diameter tubes, 6 to 8 inches and above, are used with low pressures and are often welded.

Tubes of all the above compositions have given long and satisfactory service. They are subject to some ills which must be considered.

If the fuel used is a crude oil bottom that contains vanadium salts in any quantity, the fairly rapid destruction of any of the above metals can be predicted. Also, if the bottoms are loaded with caustic or other alkalis, destruction will be fairly certain. A sulfur-free gas fuel is preferred.

Hydrogen sulfide contacting the above alloys at 1600-1800 F. or hotter can cause destruction. Fuels, including gases, containing hydrogen sulfide must be completely oxidized at the burner so no hydrogen sulfide will strike the hot tube walls. The alloys have a fair tolerance for sulfur dioxide and this tolerance increases with diminishing nickel contents, i.e., Type 310 (20 percent chromium, 20 percent nickel) would be most resistant with chrome-nickel (20 percent chromium, 35 percent nickel) next. Both would be quite adequate for natural gas fuels or refinery gases from which the sulfur is largely stripped.

The function of the burner is important. If mixing is poor, hydrogen sulfide can be formed at the tubes by a reaction of unburned methane with sulfur dioxide. Corrosion of the tube metal may follow.

Type 310 (25 percent chromium, 20 percent nickel) may suffer from

the precipitation of a *sigma* phase over the area of the tube serving at 1100 F. to 1600 F. The *sigma* phase usually precipitates after long exposure at high temperature. It appears to be an iron-chromium compound and is quite brittle. Cracks formed in this compound can apparently propagate under the stresses of service and cause failure. To avoid this danger, the tubes of Type 310 alloy can be periodically heated to 1800-1900 F. for their full length. This treatment places the *sigma* complex again in solution. High nickel (79 percent nickel, 15 percent chromium) and chrome-nickel (35 percent nickel, 20 percent chromium) are not subject to *sigma* formation.

During the production of hydrogen by partial oxidation of hydrocarbons in an atmosphere of concentrated oxygen extremely high flame temperatures are produced. The flame temperature is so high that the major problem is to prevent the metal burner from melting.

Proper design becomes a vital matter. Thermal conductivity of the metal is often a factor in keeping the burner parts cool. It is so important that materials such as copper and/or pure nickel have been considered for the burner parts. However, greatest protection can be obtained by water cooling a heat resisting alloy. Type 310 stainless, high nickel (79 precent nickel, 15 percent chromium) and chrome-nickel (35 percent nickel, 20 percent chromium) are being studied for application as burner parts. Silicon carbide is widely and successfully used.

In order for hydrogen to enter and traverse a steel or alloys, it must be in the atomic form. As the temperature of the metal and the hydrogen increases there is more disassociation of the hydrogen molecule and a greater number of atoms of hydrogen are available to enter the metal. Increased hydrogen partial pressure favors the entrance of hydrogen into the metal and its travel through it.

Three unfavorable effects of hydrogen upon steel are:

1. Decarburization

2. Blistering

3. Cracking

The last two effects will be noted in the case of the high alloys. Decarburization is not a factor due to high chromium contents.

Decarburization at Elevated Temperatures—At elevated temperatures the atomic hydrogen in the metal is quite active and will combine with carbon, sulfur, silicon and oxygen of the metal.[1] The attack upon the carbon is the most dreaded since the removal of the carbon tends to lower the strength of the steel. Carbon removal causes voids to be formed that allow a recombination of atomic hydrogen to the molecular form. As this reaction proceeds, pressure builds up in the void since the molecular hydrogen cannot enter the metal and swelling of the metal may occur.

Meet the Author

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Carbon in the steel or alloys can be stabilized against hydrogen attack by using certain alloying elements that form carbides. Such elements are chromium, vanadium, molybdenum, titanium, tungsten and others. This writer has observed that a steel containing a number of carbide forming elements appeared to be more stable than a high chromium stainless steel as Type 410. Some attack was observed upon the 410 alloy (approx. 0.15 percent carbon, 12 percent Cr) while none occurred on an alloy of 5 percent molybdenum and 0.25 percent carbon.

Chrome-vanadium steels as AISI 6120 and 6110 have proved quite successful in resisting hydrogen decarburization. The low carbon alloy steel has been used where low hardness was desired in a special part as a lens or gasket part of a joint. Both alloys have found service in equipment exposed to hydrogen at temperatures of 600-1000 F. The chromium-molybdenum steels of the 1400 Series possess quite good resistance to hydrogen attack. The molybdenum content enhances the creep or stress-rupture strength of these alloys. The 4300 Series of steels, the nickel-chrom-molybdenum type, are also quite resistant and their superior mechanical properties suggest them for bolt material for service at temperatures up to 1000 F. even in the presence of hydrogen.

Hydrogen attack upon steel appears to be a function of:

- Partial pressure of the hydrogen.
- The temperature of the metal.
- The temperature of the hydrogen.

From the above it would seem that the logic of prevention of attack would be to prevent high-pressure hydrogen from contacting the important parts of the vessel. This is accomplished by lining important vessels with a resistant steel or alloy. To prevent any build-up pressure between the liner and vessel, holes are drilled through the vessel wall. In the elaborate installations there is a groove cut as a continuous thread on the outer face of the liner and the holes drilled through the steel shell are pitched to a different angle than that of the groove so that the contact will occur between grooves and holes at various locations. An internal insulation aids in keeping the vessel walls at a low temperature, thus helping to guard against hydrogen attack and maintaining a better order of creep or stress to rupture strength in the walls.

Blistering—A phenomenum of interest and some concern to the petroleum industry is the tendency of hydrogen to produce blisters in steel and alloys.[2] The mechanism of blister formation is that atomic hydrogen within the metal finds a flaw, enters and forms molecular hydrogen by combining with another atom. The molecular hydrogen apparently cannot re-enter the metal so the pressure within the void is built up by the continuous entrance of the atoms and their reaction to form molecules.

When the yield strength of the metal is reached, plastic deformation follows producing a blister or other form of expansion. As the stress in the blister increases, the metal may rupture, thus reducing the area of metal to resist operating stresses.

M-O-C for Hydrogen . . .

Blisters on the outside of a vessel are easily detected while those on the inside are found only on careful inspection. Cases are reported where nearly half the wall thickness was lost without there being external evidence.

Blistering is a function of both the presence of hydrogen and voids in the metals. It can best be prevented by removing the possibility of hydrogen entering the metal. At elevated temperatures, the use of a liner has been suggested. This liner may be of steel so alloyed with carbide forming elements as to be immune to decarburization. Alloys or unalloyed steel may be used for liners at lower temperatures, say room temperature to 500 F.

At the lower temperature where liquid water can exist, the hydrogen will usually result from reaction between a compound of the gas as hydrogen sulfide and steel. The moisture must be present to provide an electrolyte.

Inhibitors have been used with varying success in preventing this reaction between the vessel and the gas. Hydrogen sulfide reacts in this way and gives up atomic hydrogen that can enter the metal. Action has also been taken, in many cases, to remove those materials that act as "poison" catalyst to induce hydrogen to enter the metal. Cyanides, phosphides, arsenic and other materials can act as such catalysts. Unfortunately, iron sulfide itself is such a catalyst and is formed if there is a reaction between hydrogen sulfide and steel. The use of the liner seems a more certain method of protecting the walls of reaction vessels, storage vessels and other equipment subject to corrosion.

Where the liner is of a material subject to attack by the contained fluids some arrangement must be made to vent the hydrogen that builds up between the liner and vessel. A possible theoretical advantage for a "noble" liner of stainless steel, monel, copper or other material "noble" to steel, is that the liner acts as a cathode and would receive hydrogen in preference to local cells on the face of the vessel wall. However, not all local cells on the steel face would be abolished by the use of a "noble" liner.

Cracking of High Strength Steels and Alloys—Low Temperatures—A matter of great importance to any unit using high strength alloys in the presence of hydrogen is the ability of hydrogen to cause cracking and rupture of high strength steels and alloys.[3] The hydrogen must be in the atomic form to enter and traverse the walls of the equipment. Generally the hydrogen results from a local reaction between the wall of the vessel and a hydrogen-bearing gas, usually an acid gas. Moisture must be present on the vessel wall for such a reaction to take place.

Atomic hydrogen in the metal causes cracking due to the microstresses resulting from:

- Transformation to martensite in the case of steels.
- Stresses residing in areas of heavy cold work.
- Action of high tensile stresses approaching the yield strength.

Failures apparently occur only when the metal has a yield strength in excess of 55,000 pounds per square inch.

Sometimes a member as a valve stem, if made of metal "noble" to its surrounding will receive hydrogen due to its cathodic position relative to the other metal. If high tensile stresses due to cold work reside in the part failure may occur. Here both parts must be joined by an electrolyte for the cell to be effective.

Pieces of equipment that have failed due to hydrogen cracking are: springs of valves, stems of valves, bolts, nipples, fittings, tool joints, tubing, and casing of oil wells and many other parts. Cadmium plating serves to protect springs and springs of an alloy of 79 percent nickel and 15 percent chromium have been reported as serving well in the presence of moist hydrogen sulfide.

High alloy valve stems made of high strength stainless of K-Monel may be subject to hydrogen attack. This attack is due to the valve stem being cathodic (noble) to the steel parts in the presence of an electrolyte. Some consider it wise to reduce the potential between the parts by nickel plating the steel parts.

To avoid hydrogen cracking of metallic parts of equipment it is well to avoid contact by the part with moist hydrogen containing acid gases or fluids. Since failure is a function of the presence of hydrogen and a high order of tensile stresses, low stresses in the metal are desirable. Tubing lined with monel is being tested by the production division of the petroleum industry. In this case, a monel tube is drawn into the steel tube and hydraulically expanded.

This mechanical fit leaves space behind the liner where any hydrogen liberated as during acidizing can recombine into the molecular form and thus be inert to the steel part protected. The same technique can utilize other lining materials as stainless and special alloys containing approximately 0.05 percent carbon, 40 percent nickel, 21 percent chromium, 3 percent molybdenum, 1.75 percent copper, and an alloy of 79 percent nickel and 15 percent chromium. The last alloy has approximately the same coefficient of thermal expansion as steel, which would be useful in avoiding buckling stresses as the temperature rises.

Bolts that can become loaded with atomic hydrogen offer a difficult problem. A material normally resistant to hydrogen cracking as k-monel, austenite stainless steel and alloys can be used. Care must be exercised in loading these bolts in order not to introduce cold work, i.e. exceed the yield strength. A torque wrench is considered advisable to load bolts subject to hydrogen penetration.

From the above it will be noted that hydrogen can be a potent destroyer of metals. At elevated temperatures (above about 600 F.) the atomic hydrogen coursing through a steel or many alloys tends to decarburize the metal unless the carbon is fixed by complex alloying. The hydrogen can also do mechanical damage by collecting in metal voids and distorting the metal by building up an internal pressure.

At metal temperatures where water can exist a number of compounds will react with the metal to liberate atomic hydrogen. Once in the metal this hydrogen can cause blistering and distortion and also mechanical failures. The most spectacular mechanical failures are associated with high strength metals (above about 55,000 psi yield strength) that are severely cold worked or that are acted upon by high residual or external tensile stresses of a high order.

LITERATURE CITED

[1] J. S. Vanick, "Deterioration of Some Metals in Hot Reducing Ammonia Gases." Proceedings A.S.T.M., Vol. 24, 1924, Part 2, Pages 348-372.

[2] "Blistering and Embrittlement of Pressure Vessel Steels by Hydrogen," G. A. Nelson and R. T. Effinger. The Welding Journal Research Supplement, January 1955 (Author's Note: This is an excellent paper for study by one confronted with hydrogen attack).

[3] Symposium of N.A.C.E. Galveston Meeting, "Symposium on Sulfide Stress Corrosion," *Corrosion*, Vol. 8, Oct. 1952, No. 10, Publication No. 52-3.

[4] "High Temperature Hydrogen Sulfide Corrosion" by E. B. Backensto, R. E. Drew and C. C. Stapleford, *Corrosion*, Jan. 1956, Vol. 12, No. 1.

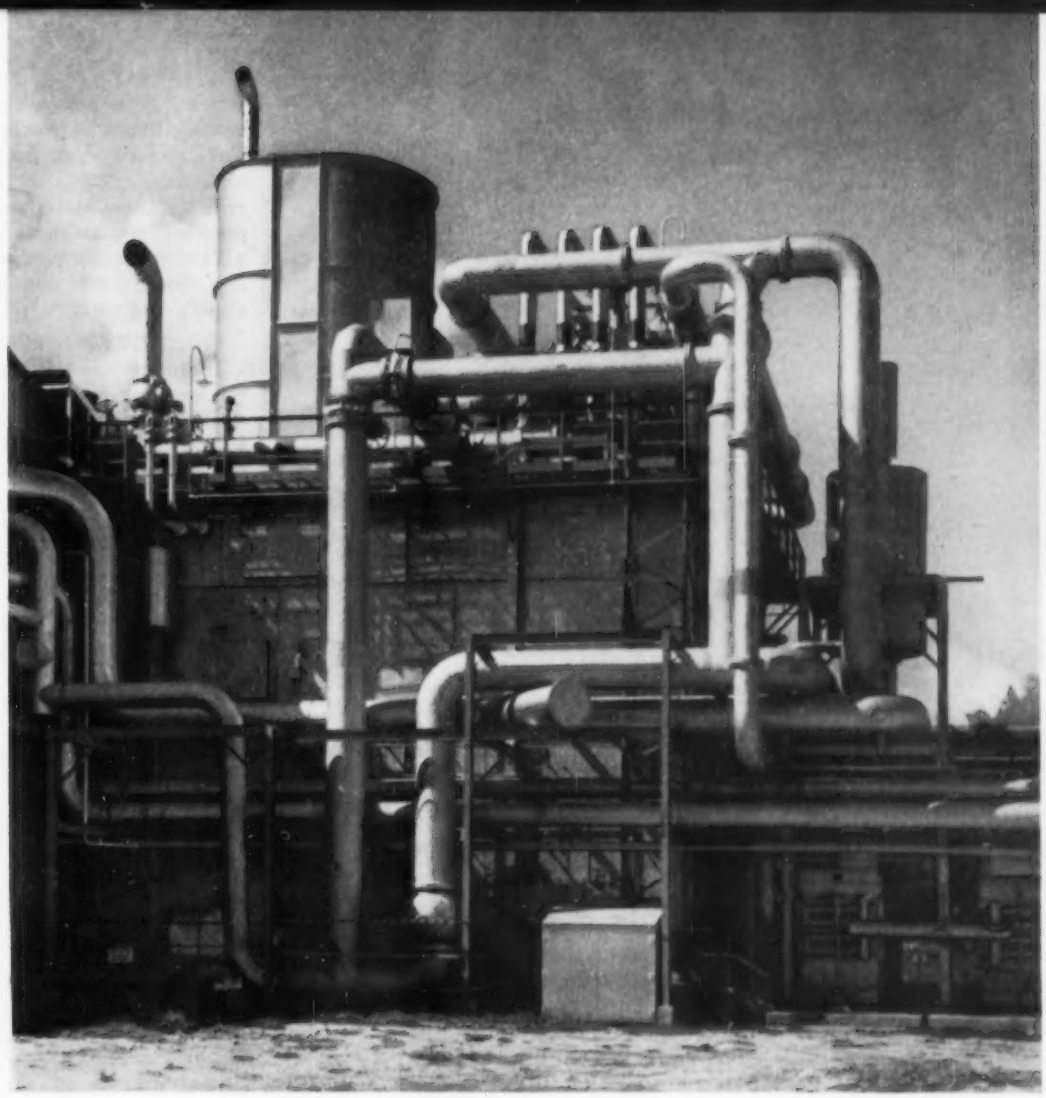

FIGURE 1—Oxygen plant.

Integration pays off at . . .

Fortier Plant of American Cyanamid

Acetylene • Ammonia • Hydrogen Cyanide • Acrylonitrile

S. Strelzoff
Chemical Construction Corporation, New York

THE NEW petrochemical plant of American Cyanamid Company, the Fortier plant at Avondale near New Orleans, went into full production last year. American Cyanamid's wholly owned subsidiary, Chemical Construction Corporation, was charged with the over-all design and construction of this huge installation.

The Fortier plant consists of several highly integrated process plants, the oxygen plant, the acetylene plant, the ammonia plant, the hydrogen cyanide plant, the acrylonitrile plant, the ammonium sulfate plant, and the sulfuric acid plant.

The designs for the acrylonitrile and hydrogen cyanide plants were based on information developed in Cyanamid's own pilot plants. For acetylene, designs were based on the BASF process for which Chemical Construction Corporation holds an exclusive license in North America. Supply of the oxygen plant facilities was awarded to the Linde Company of Germany.

The sulfuric acid, ammonia and

American Cyanamid's Fortier Plant . . .

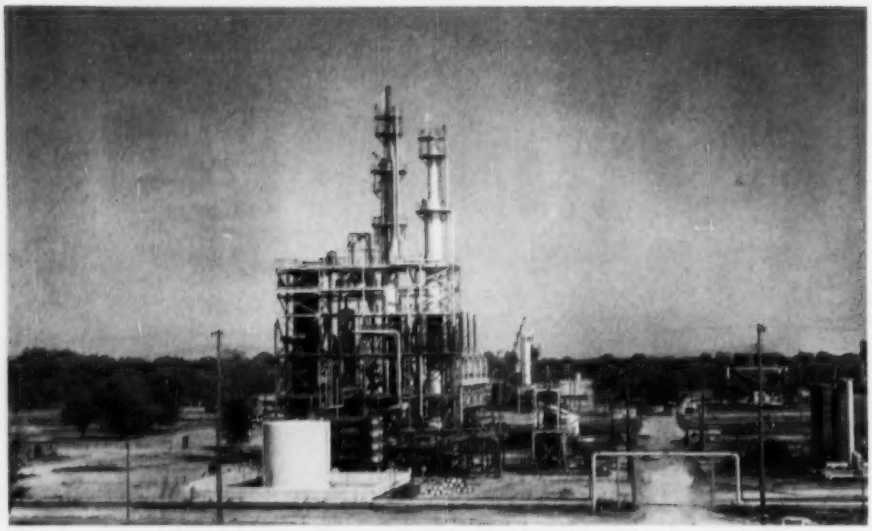

FIGURE 2—Acetylene plant.

ammonium sulfate plants, were designed by Chemical Construction Corporation.

Pilings and major building foundations were subcontracted to local construction organizations. Local subcontractors were also called upon to do the electrical work and to design the offices and the medical, cafeteria, warehouse and other auxiliary buildings.

The selection of the site on the western bank of the Mississippi River was based on several technical and economic considerations.

Sufficient quantities of low cost natural gas were available while the Mississippi River provided an unlimited water supply. Other factors were the easily available transportation facilities by land water routes and the plentiful labor supply. Finally, the climatic conditions permitted outdoor construction of many of the major process plants. Finally, the proximity of the port of New Orleans offered the possibility of exporting certain finished products (mostly fertilizer) to neighboring Caribbean countries and abroad.

At the Fortier plant, natural gas is the primary raw material for the manufacture of acetylene and hydrogen cyanide. These two intermediate products are then combined to form acrylonitrile. Byproduct gas from the acetylene process is used for the synthesis of ammonia. The secondary raw materials, sulfur and air, are used to produce sulfuric acid and ammonium sulfate while the necessary nitrogen and oxygen are obtained by the fractionation of air.

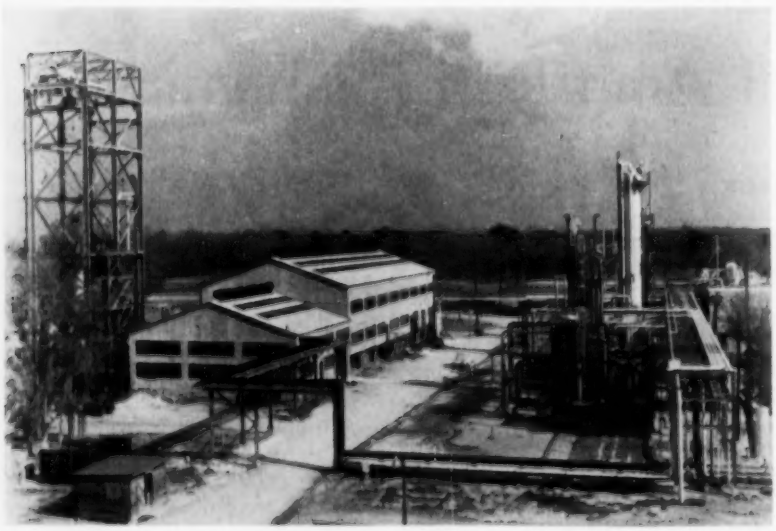

FIGURE 3—Ammonia plant.

OXYGEN PLANT

In the selection of the oxygen process, importance was attached to:

- Dependability of equipment.
- Low power consumption.
- Steadiness of oxygen flow with a purity of no less than 95 percent ±.5 percent and the necessity of producing a certain amount of nitrogen of high purity (99.7 percent nitrogen minimum) for subsequent use in ammonia synthesis.

An oxygen stream of 95 percent purity is required for the manufacture of acetylene. To supply this stream and also a stream of high purity nitrogen for the ammonia plant and for purging, a Linde low-pressure oxygen plant was bought and erected. The process uses the Linde Frankl cycle.

Air at 60 psig is first cooled in precoolers, then further cooled in regenerators and, finally, sent to a high-pressure column where the initial separation takes place. In this column the pure oxygen and nitrogen products are made. To obtain the low temperature necessary for air separation, a side stream of air is bled off part of the way down the regenerators and sent through expansion turbines where it is cooled. Pure oxygen from the bottom of the low-pressure column flows through a coil in the center of the regenerators to an oxygen compressor. This compressor feeds the oxygen to the acetylene plant. Pure and waste nitrogen flow through the regenerators during the regenerating cycle; thus they cool the regenerator packing for its cooling cycle. The pure nitrogen is then compressed for use in the ammonia plant and for purging in various processes. Figure 1 shows a picture of the plant.

ACETYLENE PLANT

The scheme for the production of acetylene from natural gas by the BASF process has been described in the literature. Essentially, natural gas is fed to a specially designed burner in which part of the gas is burned to furnish the heat necessary to crack the rest of the natural gas. A gas containing about 8 percent

acetylene, together with larger amounts of hydrogen and carbon monoxide, is produced. The acetylene is absorbed by a special solvent and the off-gas sent to the ammonia plant. The solvent is then stripped of the acetylene and recycled. A stream of better than 99.8 percent acetylene is sent to the acrylonitrile plant. Figure 2 shows the absorbing and stripping section of the plant.

AMMONIA PLANT

The off-gases from the acetylene plant contain approximately 60 percent H_2, 28 percent CO, 4 percent CO_2, 5 percent CH_4, together with very small quantities of acetylene and other impurities.

This gas first flows through a CO-oxidation unit in which steam is added and the following reaction takes place:

$$CO + H_2O \rightarrow CO_2 + H_2$$

Next, the CO_2 is removed by a monoethanolamine unit. The gas is then finally purified in a liquid nitrogen wash unit. This unit removes the last traces of CH_4, CO, CO_2, and C_2H_2. Also, in this unit, the necessary amount of nitrogen is added to form the correct ratio of N_2 and H_2 for ammonia synthesis. The gas is then compressed to about 5250 psig and converted into ammonia by the NEC process. Figure 3 shows CO oxidation and CO_2 removal sections of the plant.

HYDROGEN CYANIDE PLANT

Hydrogen cyanide is produced by passing a mixture of natural gas, ammonia, and air over a platinum gauze. A reaction according to the following equation takes place:

$$2CH_4 + 2NH_3 + 3O_2 \rightarrow 2HCN + 6H_2O$$

After passing through the reactors, the gases pass to ammonia absorbers where they are contacted with sulfuric acid. All the excess ammonia is thus formed into ammonium sulfate which is sent to the ammonium sulfate plant. The remaining gas from the ammonia absorbers then goes to the hydrogen cyanide absorbers where the hydrogen cyanide is absorbed in water. To produce pure hydrogen cyanide, the rich liquid from the hydrogen cyanide absorbers is sent to a stripper where the hydrogen cyanide is produced as the overhead product. A picture of the plant is shown in Figure 4.

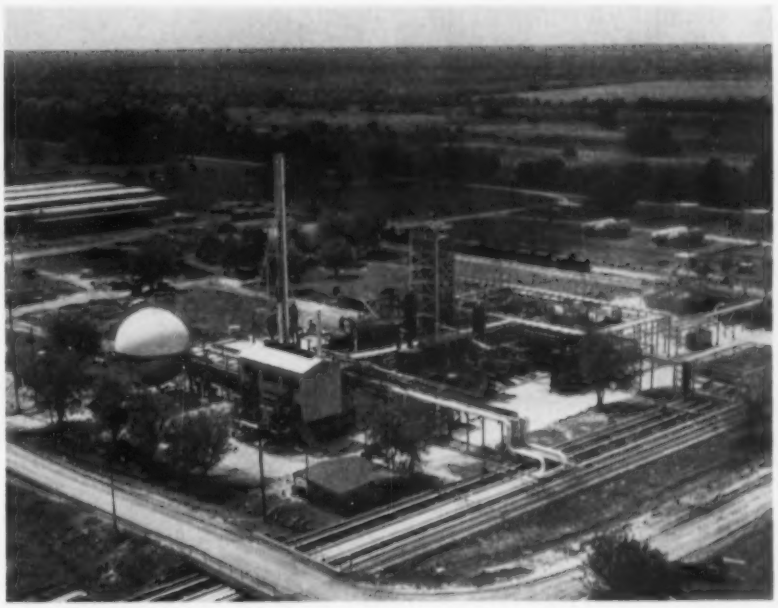

FIGURE 4—Hydrogen cyanide plant.

ACRYLONITRILE PLANT

Acetylene and hydrogen cyanide are combined in a liquid-phase catalytic reactor to form acrylonitrile together with several by-products such as monovinyl acetylene, divinyl acetylene, cyanbutadiene, vinyl chloride, etc. The gases from the reactor are cooled and passed into an absorption column where the acrylonitrile is absorbed together with some of the impurities. The rich liquid is sent to a stripper where the acrylonitrile is recovered together with the absorbed impurities. The vapors from the stripper are condensed and passed through a series of distillation steps from which pure acrylonitrile is produced. Figure 5 shows a section of the plant.

SULFURIC ACID PLANT

The sulfuric acid plant is a standard contact sulfuric acid plant using elemental sulfur as the raw material. Figure 6 shows part of this plant.

AMMONIUM SULFATE PLANT

This plant is designed to process ammonium sulfate liquor from the hydrogen cyanide plant and also to produce ammonium sulfate by the direct reaction of ammonia and sulfuric acid. Briefly, the plant consists of a crystallizer in which sulfate crystals are formed, a centrifuge for separating the crystals, a drier for drying the crystals and conveyors to convey the crystals to the storage building.

UTILITIES

Steam is produced in a large central boiler plant designed to supply 600,000 pounds per hour at 600 psig, 750 F. This high-pressure steam is used to drive several large centrifugal compressors and other equipment in the process plants. Steam at 150 psig and 45 psig is used for various processes. The 150 psig steam is obtained partly from waste heat boilers in the process plants while the 45 psig steam

Meet the Author

S. STRELZOFF, now general sales manager for Chemical Construction Corporation was onetime chief project engineer at the Fortier plant. With Chemico since 1941, he started as a designer of nitric-acid, ammonium-nitrate, ammonium-sulfate and formaldehyde plants, later serving as the company's head of research and development, chief process engineer, technical representative in Europe and assistant chief engineer. Before joining the construction firm, he was superintendent of TNT production for the Canadian government, and onetime assistant to the director of Belge de l'Azote. A native of Russia, Strelzoff was educated at Belgium's University of Liege, where he received a degree in chemical engineering.

American Cyanamid's Fortier Plant . . .

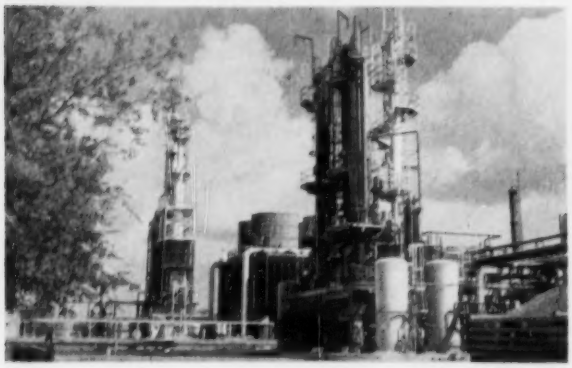

FIGURE 5—Acrylonitrile plant.

FIGURE 6—Sulfuric acid plant.

comes from turbine exhausts.

Water is pumped from the Mississippi River to a coagulating and settling basin where most of the mud is settled out and the water is partially softened. This water is used as makeup to the cooling tower. Boiler feed water also comes from the cooling tower. However, it is further softened before use.

Electrical power is supplied at 110,000 volts by a public utility company. It is distributed throughout the plant at 13,800, 4160 and 440 volts.

Considerable refrigeration is required by the process plants. The compressor which supplies this refrigeration is housed in a central compression building together with other compressors. These compressors include the air compressors supplying air to the oxygen and hydrogen cyanide plants, the oxygen compressor, the nitrogen compressor and the instrument air compressors. The placing of these compressors together reduces the maintenance cost and enables a single experienced operator to look after them.

Since the Fortier plant produces a variety of toxic chemicals, an elaborate system of effluent treatment has been installed. The effluents from the various processing plants are combined and taken to a lagoon where they are treated with caustic to raise the ph to about 9.5. The waste liquid is then sent through a chlorinator and a further caustic neutralization step before it goes into the river. As proof of the harmlessness of this effluent, fish are put into the stream and their continuing life is the best check on the efficiency of this treatment.

In view of the favorable climatic conditions, most of the equipment in the process and utility generation areas was installed outdoors. An exception to this rule was the compression equipment which, as mentioned before, was housed in one central building. It was felt that indoor installation was required here to permit proper maintenance of this critical equipment and to protect operating personnel during the seasonal rains.

A great effort was made to equip all process plants and utility installations with a maximum of automatic instrumentation. Equipment of this type alone cost more than $2,000,000. This general principle was followed not only in order to minimize manpower requirements but also to insure the safety of the process operations, most of which are rather hazardous. The industrial-scale manipulation of natural gas, acetylene, hydrogen cyanide, hydrogen, etc., requires expert and sustained supervision on the part of the personnel to avoid the danger of explosion or industrial poisoning.

In addition to the use of the most modern safety devices throughout the individual process plants, the plant areas themselves were purposely separated by wide avenues. This, of course, increased greatly the piping necessary for yard facilities, but it was decided that the additional cost was fully justified by the safety factor gained.

Actual construction of the Fortier plant was started in May 1952. The initial work was the development of general site facilities, roads, temporary power lines, railroad spurs, etc. At the same time, piling was being driven for warehouses, main work shops, administration buildings, and for the heavy equipment foundations in the utility generation and process areas. As process equipment arrived at the site, assembly and erection was immediately started.

The sulfuric acid plant was completed first and went into operation in February 1953. In August 1953, the ammonium sulfate plant was completed and put into production. The more important and complicated plant units such as the oxygen and acetylene plants naturally required more time for erection. As a matter of fact, completion of the whole project was somewhat behind the original schedule.

The booming industrial development of the New Orleans area led to unforeseen shortages of the specialized craftsmen necessary to such an undertaking. Nevertheless, the various plant units were gradually completed and put into successful operation. At the present time, the Fortier plant is producing all intermediate and final products and plans are currently under way for further expansion and diversification.

The main final product, acrylonitrile, is expected to be used on a large scale in the manufacture of synthetic fabrics and rubber as well as for the treatment of cotton. This latest development promises to be of inestimable value to the cotton industry. Instead of displacing cotton, acrylonitrile will undoubtedly further expand its use throughout the textile industry. Thus, modern technology contributes once again to the development of the enormous economic potentialities of the South.

LITERATURE CITED

[1] Petroleum Refiner, Vol. 33, No. 12, p. 160, 1954.

NOMOGRAMS . . . Make Your Own

Part 1. How to prepare various types of scales

Part 2. Laying out the nomogram

Part 3. How to prepare different types of nomograms

Part 4. How to handle experimental data directly

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Rectification of Experimental Data

Before a nomogram can be constructed from experimental data or from correlations which are derived from experimental data and are available in graphical or tabular form, it is necessary to: (1) derive an equation relating the variables; or (2) find a method of plotting on coordinate graph paper such that straight lines are obtained. Some data are linear on the common types of graph paper such as arithmetic, semi-log or log-log, etc. Frequently, however, it is necessary to devise an empirical ordinate or abscissa in order to achieve the linear plot.

The process of finding or devising a linear coordinate plot is called rectification. The objective of rectification is to cause not just one but each member of a family of curves to form a straight line.

The rectification of experimental data is given extensive treatment in a book "Empirical Equations and Nomography" by Dale S. Davis who uses "curve-fitting" equations to accomplish the desired result. The procedure described is valuable background information. If the desired end result is a nomographic presentation or correlation of the data, it is not necessary to derive the equation of the relationship. It is only necessary to devise a linear coordinate plot which may then be transformed into nomogram.

The effects of temperature and pressure on the physical properties of matter are subjects which continually are under investigation. The rectification of such data has been found to result in pressure scales that are frequently logarithmic in nature. Temperature scales fall into several classes among which are arithmetic, logarithmic and reciprocal functions. There is, of course, no rule to determine which form a variable may take.

Procedure for Rectification by Use of an Empirical Family of Lines. The procedure described below is for the rectification of experimental data in three variables. It is based on the assumption that the relationship can be represented by the following functional equation. This assumption is valid for many physical relationships.

$$f_1(y) = f_2(z)\, f_3(x) + f_4(z)$$

where

- $f_1(y)$ is a simple function of one of the variables; i.e., in form is arithmetic, logarithmic, reciprocal, etc.
- $f_2(x)$ is a function of either of the other variables, the complexity of which is immaterial.
- $f_2(z)$ and $f_4(z)$ are functions of the remaining variable, the complexity of which is immaterial.

The process of rectification involves assuming the functional form of one of the variables, i.e., $f_1(y)$ as defined above, and checking of this assumption by a relatively simple means. The end result is a linear plot of the relationship with $f_1(y)$ as the ordinate and $f_3(x)$ as the abscissa.

(1) Mount a sheet of arithmetic graph paper on the drawing board. Let the set of horizontal lines, i.e., the ordinate, represent one of the three variables. Use of arithmetic graph paper is equivalent to the assumption that the variable is arithmetic, i.e., that $f_1(y) = y$. An examination of the data may give a clue as to which variable is most likely to be linear.

(2) Calibrate the Y-axis to cover the range of values of the variable.

(3) Let the vertical set of lines represent either of the remaining two variables and calibrate the X-axis to include the upper and lower limits.

(4) Plot data for a few values of the third variable as the parameter and draw smooth curves through the resulting points. Assuming no maximum or minimum ordinate or abscissa is exhibited, proceed to step (5); if such is exhibited go to step (10).

(5) Choose a curve representing any value of the parameter, but preferably one which cuts all values of the abscissa and connect its extremities with a straight line.

(6) Using this straight line to represent that value of the third variable, lay out an empirical abscissa scale along the top edge of the graph paper, i.e., start with a value of the abscissa on the original graph, proceed vertically to the curve, from there horizontally to the straight line, and from there vertically to the top edge of the graph paper. This results in the complete revised abscissa scale provided all of the abscissa family of line were cut in step (5); if so, go to step (7)—otherwise go to step (8).

(7) Using the revised abscissa, replot the other values of the third variable. If straight lines are obtained, the relationship may be considered to

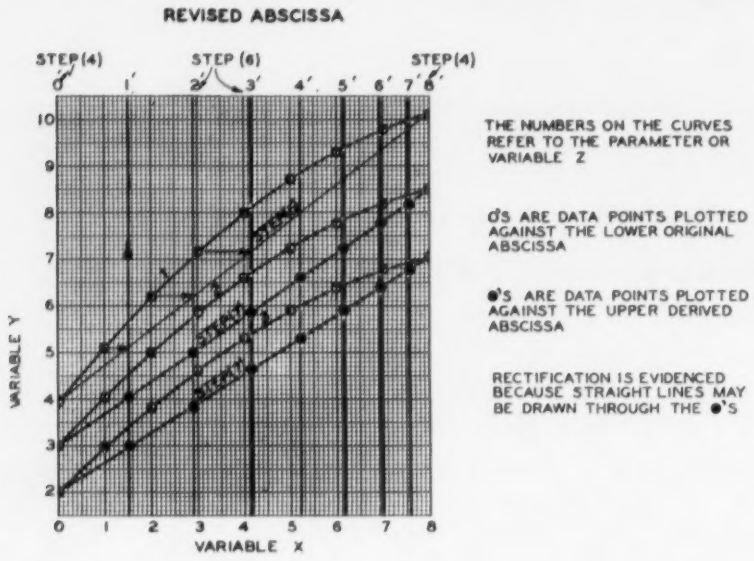
REVISED ABSCISSA
STEP(4)
STEP (6)
STEP(4)
VARIABLE Y
VARIABLE X
THE NUMBERS ON THE CURVES REFER TO THE PARAMETER OR VARIABLE Z
O'S ARE DATA POINTS PLOTTED AGAINST THE LOWER ORIGINAL ABSCISSA
●'S ARE DATA POINTS PLOTTED AGAINST THE UPPER DERIVED ABSCISSA
RECTIFICATION IS EVIDENCED BECAUSE STRAIGHT LINES MAY BE DRAWN THROUGH THE ●'S

Figure 9a

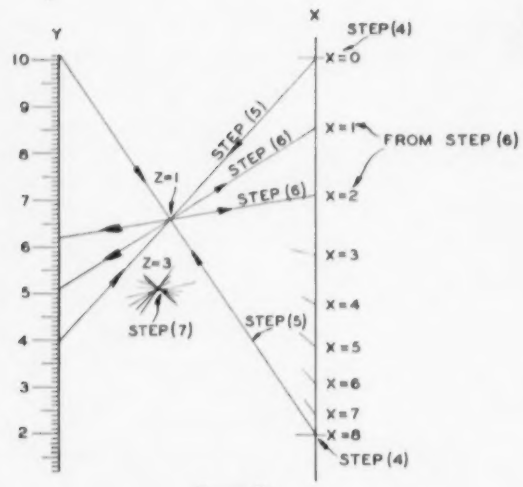

Figure 9b

FIGURE 9—Making straight line charts from non-linear data (rectification).

have been rectified. This procedure is illustrated in Example 5.

(8) If the curve chosen in step (5) does not cut all values of the abscissa, only a part of the revised abscissa can be constructed from the line connecting its ends. In this case use that part of the revised abscissa which is obtained and replot as much as possible of an adjacent value of the third variable.

(9) Draw a straight line through these points, extend to the edge of the graph paper and use it in conjunction with the corresponding adjacent curve of the third variable to construct an additional part of the revised abscissa and so on until the complete revised abscissa is obtained. If it is possible to complete step (9) the relation may be considered to have been rectified—otherwise proceed to step (10). Steps (8) and (9) are illustrated in Example 6.

(10) If straight lines are not obtained in steps (7) or (9), or if a maximum or minimum is exhibited in step (4), interchange the second and third variables in step (3) and repeat through step (9).

(11) If this does not result in rectification, use a different variable as the ordinate in step (1).

(12) If this does not result in rectification, try using a logarithmic family of lines as the horizontal set of step (1). This is the assumption that the variable is logarithmic, i.e., that $f_1(y) = \log y$. If this does not work try other standard sets of lines such as that on reciprocal and probability graph paper.

(13) If none of the readily available sets of lines results in rectification, a study of the relationship may indicate that some other function is necessary. For example, if there is reason to believe that one of the variables expressed as a square root can be related to the other variables, use of this function as the ordinate to be used in step (1) will result in rectification, provided the variable can in fact be represented as the square root, i.e., $f_1(y) = (y)^{1/2}$.

Example 5. Figure 9a is a plot of three curves drawn through circled data points in a relationship between three variables X, Y, and Z. The numbers on the curves refer to values of Z. It is desired to determine if the relationship can be rectified by use of an arithmetic Y-scale.

In accordance with the instructions in Step (5), a straight line is drawn through the ends of the curve for Z = 1.0. This line cuts all values of the abscissa and therefore step (6) is followed to construct the empirical abscissa scale shown in primed numbers at the top edge of the graph. A family of straight vertical lines is drawn through the empirical scale.

The empirical scale is used in step (7) to replot the other values of Z resulting in the solid circles. Straight lines may be drawn through these points, therefore the relationship is rectified.

A nomogram could be constructed by use of a uniform Y-scale and the empirically derived X-scale. However, in order to illustrate the nomographic equivalent of the steps used in the graphical rectification, a different method will be used as illustrated in Figure 9b. The uniform Y-scale is

constructed. On a line parallel to the Y-scale at a distance equal to the base of the nomogram the upper and lower values of X are located horizontally opposite the terminal values of the Y-scale. These two values of X are connected to corresponding values of Y for Z = 1 this being nomographic equivalent of step (5). The resulting point of intersection is used to construct the X-scale as in step (5). The resulting X-scale is used to locate the point for Z = 3. This point is the common intersection of eight construction lines and is the equivalent of step (6). The empirical X-scale has resulted in rectification because a common point is obtained. If a "scattered" intersection had been ob-

FIGURE 10—How to smooth the data. (Explanation of this figure will be found on next page.)

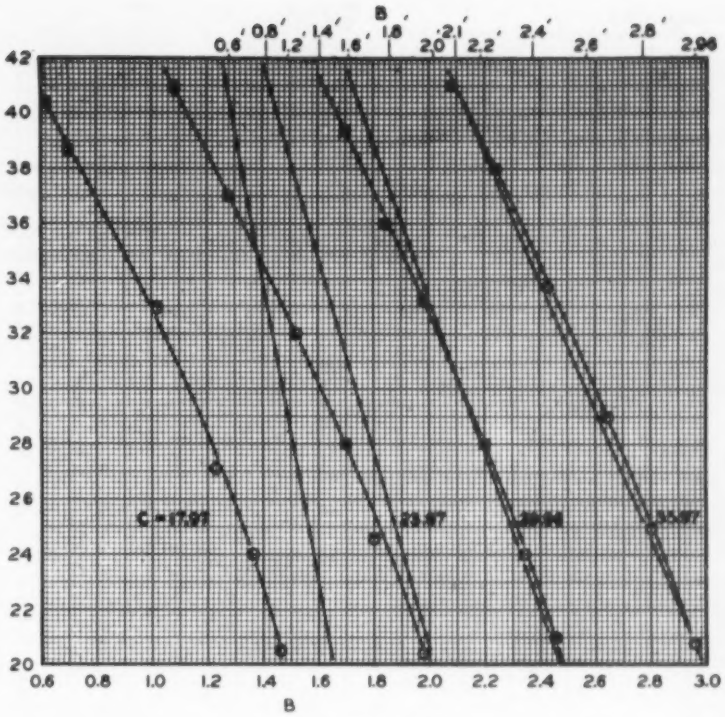

Figure 10a

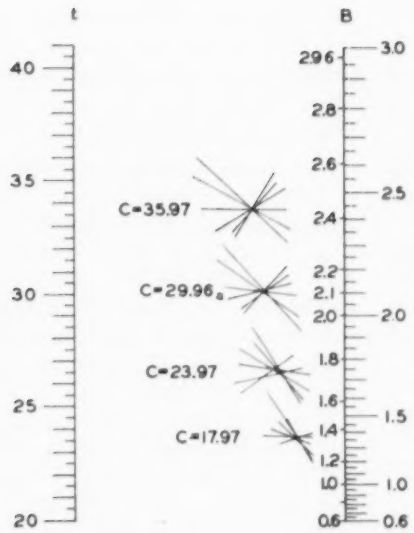

Figure 10b

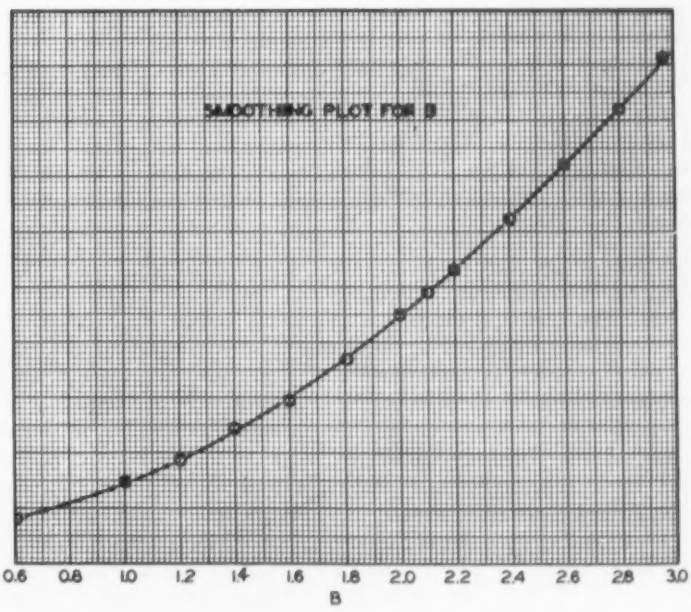

Figure 10c

tained, the rectification would not have been obtained.

Example 6. Davis in his book, "Empirical Equations and Nomography," Pages 71-75, gives experimental data covering the concentration (C) of a certain salt in grams per liter, the gravity as degrees Bé (B) and temperature (t) in degrees centigrade. The available information is tabulated in Table A.

TABLE A

B	t, °C			
	C=17.97	C=23.97	C=29.96	C=35.97
0.615	40.4	.....	.....	.....
0.70	38.7	.....	.....	.....
1.02	32.9	.....	.....	.....
1.08	.....	40.9	.....	.....
1.23	27.1	.....	.....	.....
1.28	.....	37.0	.....	.....
1.36	24.0	.....	.....	.....
1.46	20.5	.....	.....	.....
1.51	.....	32.0	.....	.....
1.70	.....	28.0	39.4	.....
1.80	.....	24.5	.....	.....
1.843	.....	.....	36.0	.....
1.98	.....	20.4	.....	.....
2.071	.....	.....	31.1	.....
2.086	.....	.....	.....	41.0
2.200	.....	.....	28.0	.....
2.243	.....	.....	.....	38.0
2.343	.....	.....	24.0	.....
2.429	.....	.....	.....	33.7
2.457	.....	.....	21.0	.....
2.643	.....	.....	.....	29.0
2.80	.....	.....	.....	24.9
2.957	.....	.....	.....	20.8

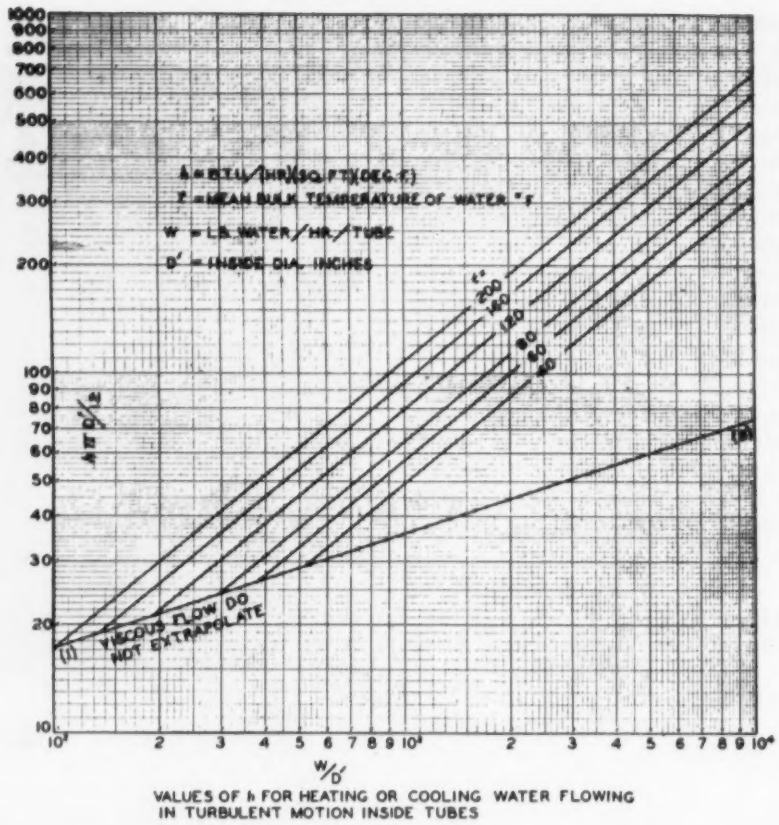

FIGURE 11—How to indicate non-extrapolation regions on coordinate and nomographic charts.

Figure 11a

The data were obtained in order that the gravity and temperature of the salt solution, which are easily determined, can be used to estimate the concentration, which is not easily determined. It is desired to correlate the data and present the results in nomographic form.

There is no method of determining beforehand which variable can be represented as one of the simple functions, i.e., arithmetic, logarithmic, reciprocal, etc. Ordinarily it would be necessary to determine this by trial and error. In this case, however, the equation of the relation was developed by Davis. (Of course, if the equation were available it would not be necessary to go through the rectification procedure). This equation is as follows:

$$B^2 = 0.02644\,(C)^{1.736} + (0.352 - 0.007\,C)\,t$$

Rearranged, the equation is compared to its general functional form:

$$t = \underbrace{\frac{1}{0.352 - 0.007\,C}}_{f_1(y)\quad f_2(z)} B^2 - \underbrace{\frac{0.02644\,(C)^{1.736}}{0.0352 - 0.007\,C}}_{f_3(x)\quad f_4(z)}$$

Thus, $f_1(y) = t$ insures that if it is the ordinate on arithmetic graph paper, the rectification will be successful.

B is chosen as the abscissa because the data are not suitable to use C. If this does not result in rectification it will be necessary to try C as the abscissa although additional experimental data will have to be obtained in order to do so. (From the equation one can also determine that B must be the abscissa.)

Figure 10a is a plot of the data with t as the ordinate and B as the abscissa. The data are plotted as the circled points on the arithmetic graph paper. This corresponds to steps (1) to (4) of the procedure. Corresponding to step (5) a straight line is drawn through the ends of the curve for C = 35.97. The top edge of the graph is marked with the empirical scale as primed numbers as in step (6). The scale from 2.1 to 2.96 is obtained from C = 35.97. This empirical abscissa is used to replot C = 29.96 from 2.1 to 2.5, step (8), this being the portion overlapped by C = 35.97. A straight line is drawn through the resulting points and extended to the top edge of the graph paper, step (9). This line and the curve for C = 29.96 is used to extend the empirical abscissa scale from 2.1 to 1.6. The remaining data are used to extend the empirical abscissa to 0.6.

The relationship may be considered to have been rectified and the construction of a nomogram is now possible. If the work just described is done carefully on large sheets of graph paper the empirical B-scale, reduced or expanded proportionately to the proper length, could be used directly in the construction of the nomogram. However, it is well to take a scale obtained in this manner and project the individual graduation marks to a calibrated sheet of graph paper. A smooth curve is drawn through the points so obtained in order to assure that there are no "breaks" in the graduation of the scale. Such a plot is called a "smooth-

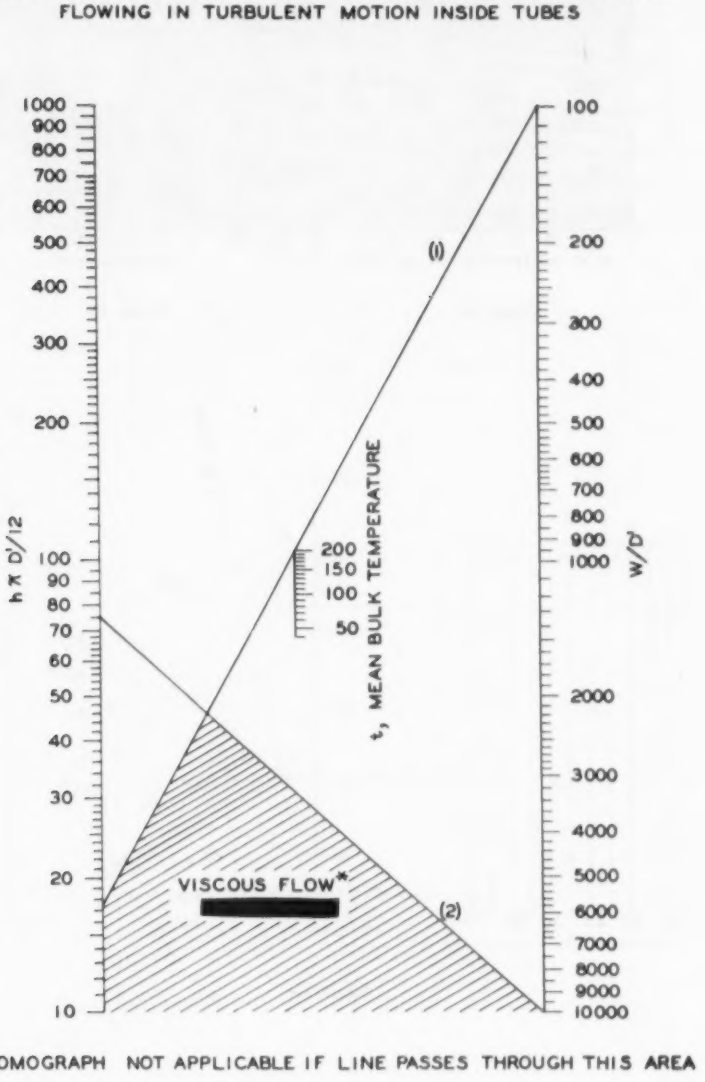

Figure 11b

ing" plot. This is illustrated in Figure 10c.

Graduation of the left edge of the B scale is taken directly from that empirically derived on the graph paper. These points are projected to the sheet of graph paper to the right and the intersections with the corresponding vertical lines of the graph paper are shown as circles.

A smooth curve drawn through these circles is used to construct the empirical B-scale of the nomogram shown on the right edge of the B-scale. The t-scale is then constructed and it is used in conjunction with the B-scale to locate the nomographic points for C = 35.97, 29.96, 23.97 and 17.97. This is shown in Figure 10b.

The completion of the nomogram is not shown but would involve drawing a curve through the C-points, and graduating the curve with whole values of C using a smoothing plot for this purpose.

Prevention of Extrapolation

Some correlations are of a nature such that they may not be validly extrapolated into certain regions. An example of such a correlation is Figure 85 of the second edition of McAdams' "Heat Transmission" which is reproduced here as Figure 11a. This correlation is valid only for turbulent motion and in order to prevent extrapolation of the chart into the region of viscous motion, the lower end of the parameter lines were "cut off" and the note "Viscous flow, do not extrapolate" was added by McAdams. The "cut off" line has been extended to intersect the right edge of Figure 11a and the two terminals of the line have been marked as points (1) and (2).

Figure 11b is a nomogram of the McAdams graph. Line (1) of the nomogram corresponds to point (1) of the graph where $h\pi D'/12 = 17$, and $W/D' = 100$; similarly, line (2) corresponds to point (2). These two lines intersect and the region which is common to and beneath both of them has been cross-hatched. This region is that corresponding to viscous flow. The note "viscous flow, not applicable if hair line passes through this area" is shown within the cross-hatched area. This means of indicating a region can be put to other uses.

How to Construct Nomographs From Limited Experimental Data

Sometimes the number of available experimental data points is limited or of a random nature and a rectilinear coordinate plot cannot be prepared. A nomogram can frequently be constructed from such data, however, by a simple trial and error procedure provided two of the scale functions are known.

The procedure is as follows:

(1) Lay out the two known scale functions in such a manner that the third variable will fall between them;

(2) Draw data lines connecting experimental values of the two scales from step (1) and label these lines with the corresponding value of the third variable;

(3) Inspect the resulting data lines from step (2) and draw in a trial line at the approximate location of the third variable scale.

(4) Using the trial scale line from step (3), prepare a smoothing plot for the third variable.

(5) Erase the line from step (3) but do not disturb those from step (2).

(6) For each point on the smoothing plot, proceed vertically to the smoothing curve, then horizontally to the corresponding data line from step

(2) and circle the point of intersection.

(7) Draw a line through the circles points obtained from step (6).

(8) Construct a new smoothing curve using the scale line from step (7) and repeat all steps from (4) to (7).

(9) If no appreciable change occurs in the location of the scale line, it may be graduated from the smoothing curve of step (8); otherwise repeat until no further refinement is justified.

Example 7. Develop a correlation relating the freezing points of the ternary system, ethanol, methanol, and water given the data in Table B. A is the percentage of total alcohols, M is the percentage of methanol in the alcohol blends, and t is the freezing point in degrees centigrade.

TABLE B

Point No.	Experimental Values of A, t, and M		
	A, %	−t, °C	M, %
1	60.0	55.0	87.5
2	56.5	36.7	5.0
3	49.8	39.0	70.0
4	47.8	35.0	55.0
5	42.5	28.0	40.0
6	35.5	25.0	100.0
7	31.0	16.2	10.0
8	25.6	15.0	95.0
9	24.3	12.0	25.0
10	20.0	10.0	65.0
11	14.5	7.0	98.0
12	10.0	3.9	33.3

The only additional information known about the system is that at a constant value of A, M is linear with t when plotted on coordinate graph paper.

A coordinate sketch of the data is shown in Figure 12a. The lines of constant values of A can be roughly sketched in as shown. A schematic nomographic form of the plot is shown as Figure 12b.

The t- and M-scales are laid out on parallel lines using an arithmetic graduation and the 12 experimental data lines are placed thereon, as shown in Figure 12c. Figure 12c is examined and a trial A-scale stem is drawn as shown. The line could have been drawn in any position.

FIGURE 12—Steps to follow when experimental data are listed.

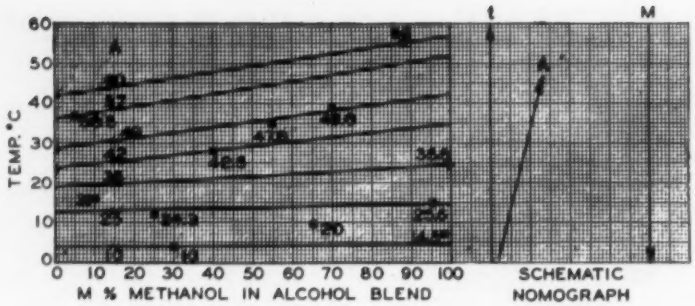

Figure 12a

Figure 12b

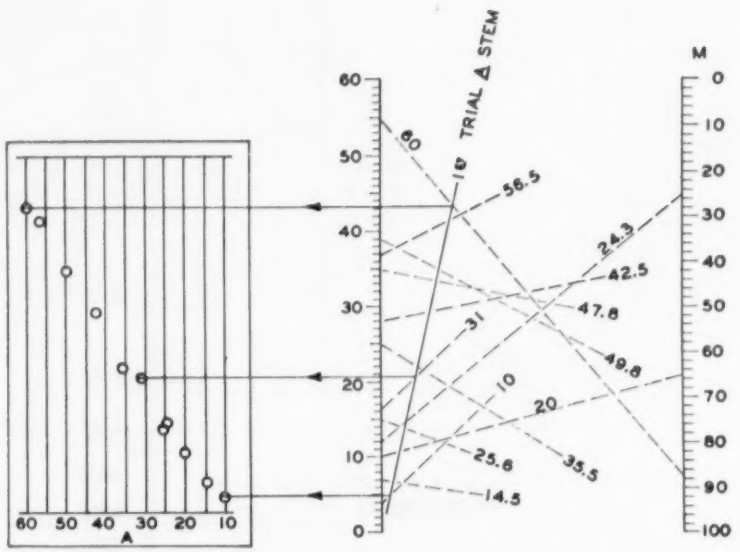

Figure 12c

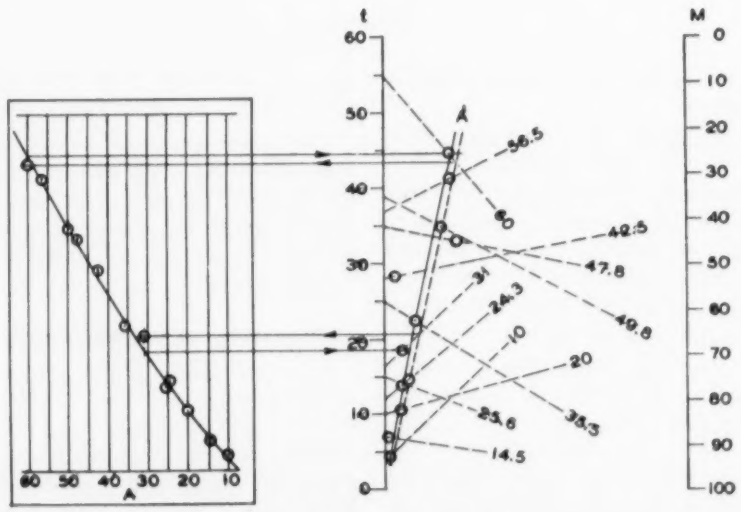

Figure 12d

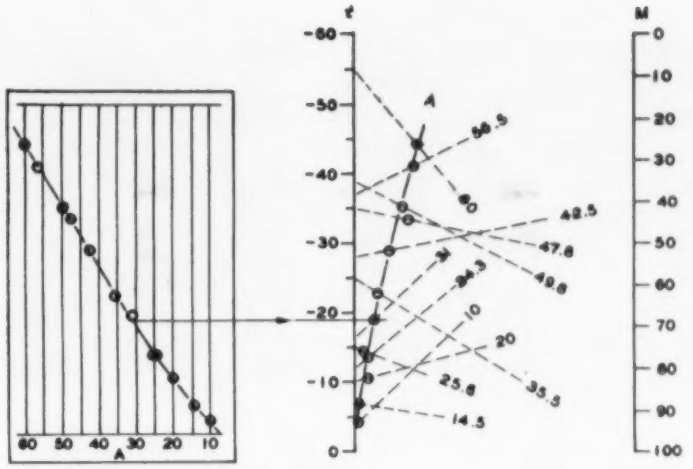

Figure 12e

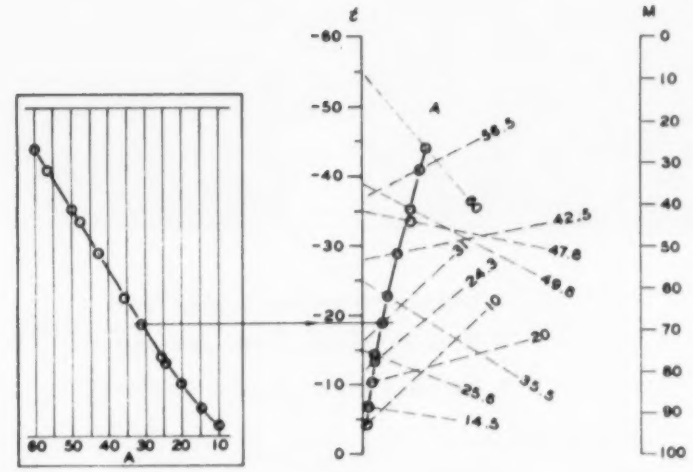

Figure 12f

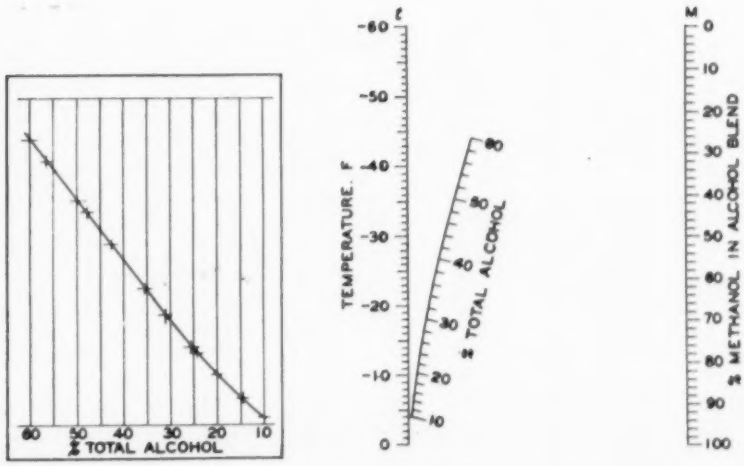

Figure 12g

A sheet of graph paper is attached to the board and the vertical lines are calibrated between the upper and lower limits of A, namely, 10 and 60. The intersections of the data lines with the trial A-scale stem are projected horizontally to corresponding vertical lines of the graph paper, and the resulting points of intersection are circled. A smooth curve, shown in Figure 12d, is drawn through the circled points.

The first trial A-scale stem is erased. Starting with one of the twelve points which are on the graph paper project vertically to the smooth curve and from there horizontally to the corresponding data line, circling the intersection. This is repeated for the remaining eleven points. A smooth curve is drawn through the resulting points on the data lines as indicated by Figure 12d. Using this line as a second trial A-scale stem and repeating the above procedure results in Figure 12e and still another repetition yields Figure 12f. Figure 12g is the final correlation.

The final correlation is compared with the original data in Table C:

TABLE C

Point No.	% A	% M	—t, °C Obs.	Nomo.	Dev.
1	60.0	87.5	55.0	55.0	0
2	56.5	5.0	36.7	36.9	+0.2
3	49.8	70.0	39.0	38.8	−0.2
4	47.8	55.0	35.0	34.6	−0.4
5	42.5	40.0	28.0	27.9	−0.1
6	35.5	100.0	25.0	25.0	0
7	31.0	10.0	16.2	16.2	0
8	25.6	95.0	15.0	15.0	0
9	24.3	25.0	12.0	12.0	0
10	20.0	65.0	10.0	10.0	0
11	14.5	98.0	7.0	6.9	−0.1
12	10.0	33.3	3.9	3.7	−0.2

This method of nomographic construction has been used very successfully to correlate bubble cap tower pressure drop data and physical properties of petroleum fractions such as molecular weight, aniline point, heat of combustion, density and viscosity. ##

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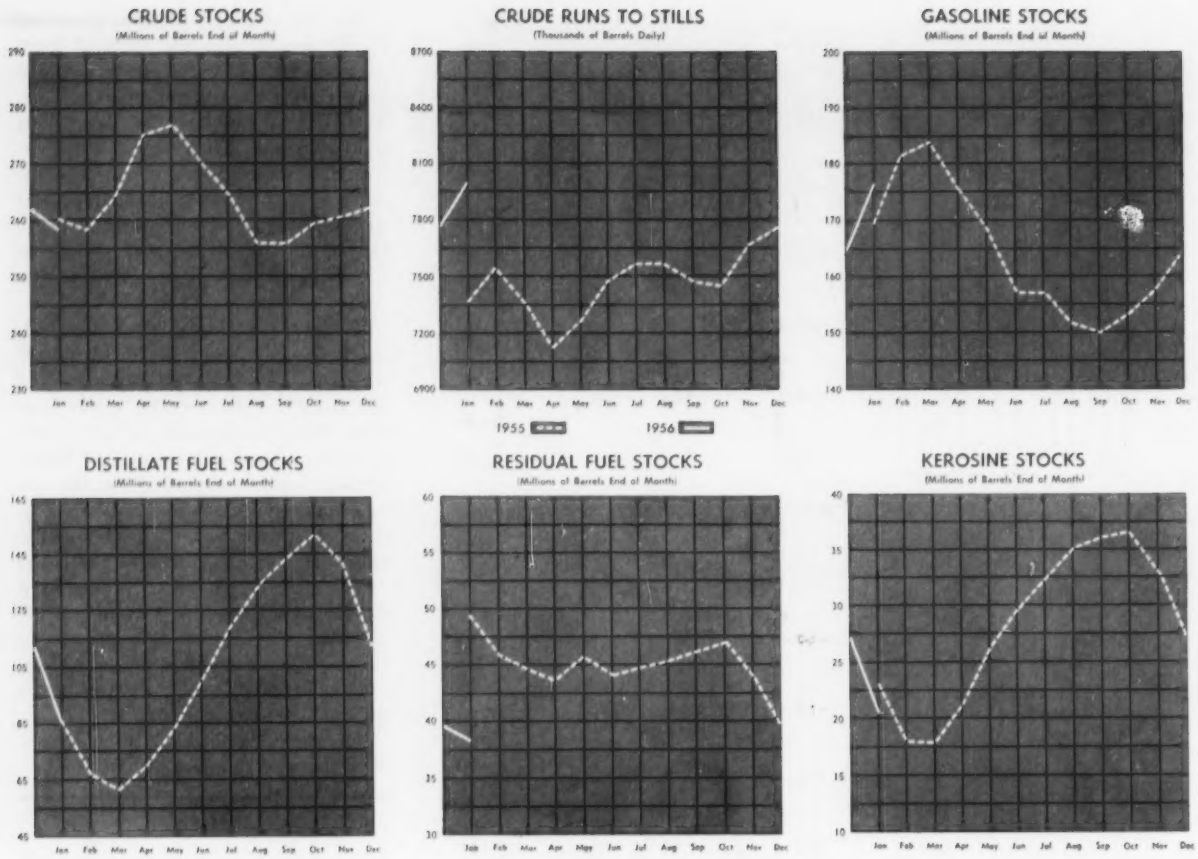

Taking Stock

Cecil W. Smith
Economics Editor

- Refinery thruput at highest level
- Heating oil output hits new peak
- Gasoline stocks continue buildup

MONTH	CRUDE OIL			GASOLINE		KEROSINE		DISTILLATE FUEL		RESIDUAL FUEL		DAILY IMPORTS	
	Production Daily	Runs to Stills Daily	Stocks End of Month	Production Daily	Stocks End of Month	Production Daily	Stocks End of Month	Production Daily	Stocks End of Month	Production Daily	Stocks End of Month	Crude Oil	Total Oils
1954:													
January	6,240	6,947	270,811	3,431	171,704	390	22,013	1,467	81,044	1,271	47,474	617	1,143
February	6,379	7,068	266,918	3,476	179,950	412	20,183	1,545	70,390	1,241	47,119	621	1,144
March	6,507	6,923	271,867	3,375	181,297	353	17,533	1,458	60,270	1,168	44,249	654	1,088
April	6,615	6,811	280,310	3,404	177,006	322	19,656	1,374	61,721	1,140	44,362	574	950
May	6,471	7,038	282,250	3,482	177,606	302	23,892	1,372	73,581	1,148	47,009	708	1,021
June	6,500	6,947	285,155	3,483	165,404	306	28,184	1,399	86,325	1,123	50,216	624	999
July	6,242	6,916	284,894	3,480	158,010	295	31,953	1,416	101,657	1,089	54,365	724	1,038
August	6,168	6,862	281,043	3,492	153,168	302	34,949	1,453	117,579	1,069	56,332	664	966
September	6,151	6,939	274,608	3,511	150,916	301	37,099	1,514	128,061	1,086	56,702	672	999
October	6,135	6,834	269,442	3,457	149,661	310	37,140	1,545	139,128	1,066	56,541	642	1,065
November	6,346	6,975	264,566	3,530	150,604	354	34,547	1,622	133,886	1,120	54,891	636	1,104
December	6,394	7,238	258,385	3,605	155,400	381	27,826	1,668	108,144	1,187	52,105	729	1,301
1955:													
January	6,761	7,379	260,156	3,639	169,562	409	23,266	1,740	86,692	1,235	49,457	739	1,348
February	6,835	7,549	258,630	3,655	181,643	374	18,291	1,847	68,513	1,239	46,042	751	1,379
March	6,886	7,374	264,430	3,543	183,972	357	18,187	1,703	62,457	1,185	44,970	742	1,319
April	6,887	7,136	275,232	3,502	175,601	312	21,486	1,534	70,139	1,110	43,838	697	1,123
May	6,677	7,281	276,948	3,605	168,751	296	26,375	1,519	83,559	1,111	45,083	742	1,137
June	6,613	7,484	270,850	3,725	157,439	269	29,830	1,628	100,652	1,080	44,398	764	1,159
July	6,632	7,580	264,601	3,824	157,079	286	32,749	1,575	119,169	1,091	44,894	860	1,161
August	6,665	7,580	256,427	3,858	151,912	290	35,292	1,621	133,675	1,090	45,480	756	1,155
September	6,731	7,483	256,269	3,784	150,194	279	36,361	1,621	143,248	1,061	46,267	829	1,218
October	6,837	7,465	267,346	3,827	153,103	309	36,705	1,612	152,288	1,123	47,040	821	1,206
November	7,014	7,692	260,707	3,867	157,871	341	33,283	1,680	141,808	1,214	44,071	823	1,324
December	6,955	7,769	262,033	3,856	164,859	360	27,437	1,772	112,792	1,343	39,872	880	1,453
1956:													
January	7,028	8,003	258,322	3,810	181,066	370	20,886	1,927	86,343	1,300	38,476	797	1,330
Week Ended:													
2-17-56	7,116	7,989	256,645	3,700	189,428	389	19,541	1,961	77,850	1,279	38,203	579	1,431
2-18-55	6,767	7,511	259,053	3,486	176,877	363	20,170	1,806	71,019	1,275	46,710	589	1,271

Source: Data for last two months from API; prior monthly data from Bureau of Mines. Data in thousands of barrels.

FIGURE 1—Monitoring system consists of timer (technician is adjusting it), an amplifier and speaker (in grill box), and a "Ding-Dong" unit at right.

A public telephone may be used for . . .

Mass Spectrometer Monitoring

Ralph W. Burhans and Warren Jackson, Jr.
The Standard Oil Company (Ohio)
Cleveland

MASS SPECTROMETERS used for control laboratory analysis are usually kept in continuous operating condition. This practice is followed at Sohio in order that a full 40-hour work week can be devoted to analysis with no time lost for start-up. Some time ago automatic liquid-air dispensing equipment was installed[1] to further insure continuous operation during unattended periods.

Occasional failures in this dispensing equipment, and power and vacuum failures during evenings or weekends resulted in considerable lost analysis time because the instrument was not ready to perform when the operators came to work. The resulting pile-up of samples, especially on Monday mornings, was serious but did not seem to occur frequently enough to warrant full-time attendance at the equipment.

In order to correct this situation, a telemetering device was constructed for use in conjunction with an ordinary telephone circuit. This device permits the operator to dial the mass spectrometer telephone number and, after listening to a series of signals, determine the condition of certain critical sections of the equipment. If maintenance is indicated the work can be initiated in time to have the instrument in operating condition by the next regular shift. Since the monitoring telephone call can be made from any telephone and only takes a few minutes, there is little objection to this method of monitoring unattended operations. The monitoring installation is shown in Figure 1.

The monitoring equipment consists of audible indicating equipment, popularly known as the "Ding-Dong,"

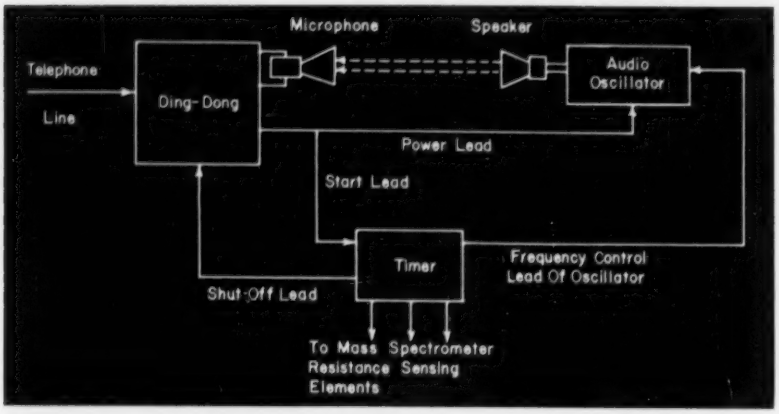

FIGURE 2—Block diagram showing the relationship of the various parts.

connected electrically to a sequence timer and by a sound path to an audio oscillator circuit whose frequency is determined by several sensing resistances in the mass spectrometer. A block diagram of the system is shown in Figure 2. The "Ding-Dong" box is an unattended station circuit supplied to subscribers of the telephone service. It was originally developed for telemetering the level of river waters during flood conditions. This box contains relays for answering and disconnecting, a microphone, a relay for starting an outside circuit, and a "ding-dong" bell. It can be connected to a PBX switchboard so that it can be put up on a night connection to an outside trunk line. When a call is received on this line the relays in the box "answer" the call and activate the microphone. Other relays operate the bell (hence the name "Ding-Dong") to indicate that the telephone equipment is working properly. At the same time another relay has operated which can be used to start the subscriber's equipment. Any sound issuing from the subscriber's equipment is picked up by the microphone and heard by the caller. The closing of an electrical contact connected to the box will cause the box to disconnect when the desired information has been transmitted.

The monitoring equipment at Sohio consists of a resistance-controlled transistor audio oscillator which feeds signals to the telephone circuit through a transistor amplifier and loudspeaker. The frequency of the oscillator is determined by the value of resistance switched into the base circuit of the transistor oscillator. The Ding-Dong box turns on the transistor supply voltage and starts the sequence timer when a call is received. The timer is arranged so that different resistance elements are successively connected to the transistor oscillator, each for about ten seconds. At the end of this sequence the timer signals the Ding-Dong box to disconnect.

At present, three resistance elements are sequentially switched into the oscillator circuit. The first two are thermistors located in the two liquid nitrogen gas cold traps at a position of safe liquid level. In this way the resistance of the thermistors is a function of the level in the traps. The third resistance element consists of one of two resistors which is selected by the contacts of the vacuum-gage alarm relay in the mass spectrometer. If the alarm is off, a high value of resistance is selected and, if the alarm is on, a low value of resistance is selected.

The audio oscillator circuit is such that a high value of resistance will cause it to oscillate at a very low frequency, and a lower value of resistance will cause higher frequency oscillations. Thus, when everything is normal, the caller will hear three separate ten-second signals of very low frequency—actually these signals have a "put-put-put" sound. However, when any of the conditions being monitored are abnormal, the caller will hear an unmistakable high-pitched tone for 10 seconds for each abnormal condition which exists.

This monitor has been in service at Sohio's Process and Products Development Laboratory and has required no maintenance except for battery replacement.

ACKNOWLEDGMENT

The authors wish to thank The Standard Oil Company (Ohio) for permission to publish this information. A patent has been applied for. The help of L. W. Salzer and R. W. Thutt of the Development Laboratory are gratefully acknowledged.

LITERATURE CITED

[1] An Automatic Liquid Nitrogen Dispenser, NBS Tech. News Bull., 36:18, February, 1952.

Meet the Authors

Jackson

Burhans

WARREN JACKSON, JR., also started in Standard's Chemical and Physical Research division in 1947. Now a technical specialist in the Process Engineering division, he is engaged in analog computation and process control. Jackson is an electrical-engineering graduate from Purdue University and holder of a master's degree from Case Institute of Technology. He served as a radio engineer with the Army Signal Corps in Europe during the war.

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Air Versus Water Cooling

In natural gasoline plants, the decision on these two cooling methods rests with a detailed consideration of numerous factors surrounding the installation.

J. J. Weatherby
Stearns-Roger Manufacturing Company
Denver

WITH ALMOST no exceptions the original heat put into a gasoline plant by fires in furnaces under boilers, oil heaters, or other equipment using primary fuel, must finally be dissipated into the air. In the great majority of plants this is done by absorbing the heat into water streams, and then cooling the water by evaporation from sprays and wet surfaces which contact air, as in any one of the many conventional types of cooling towers.

For various reasons it may be necessary or desirable to substitute for this method of cooling the use of dry air or "radiator" type cooling equipment where the heat is dissipated by heat exchange between the final commodities to be cooled and atmospheric air, without making any use of the evaporation of water. Such coolers are simply heat exchangers where the commodity to be cooled passes through nests of tubes while air is drawn or blown through them by fans.

Usually the outside surface of the tubes is extended by fins in some manner so as to expose a large metal surface to the flowing air and thus partly overcome the intrinsically bad heat transfer coefficient between the metal and air.

In general, where fresh water is available in enough quantity to meet the plant cooling requirements when using an evaporative cooling tower, and at reasonable cost, the evaporative water cooling system will almost always work out to be the cheapest and most satisfactory answer. This will probably always be true except in the case of small auxiliary plants, such as simple field compression or pumping plants, where the service does not require the attainment of low cooling temperature levels.

Some of the reasons which may make direct air cooling desirable or necessary are:

- Scarcity or absence of water at the plant site.
- Poor quality of whatever water is available at the plant site, which leads to excessive overall operating costs due to high treating costs or corrosion of the apparatus.
- Requirement of a high degree of salvageability and portability. This is an important consideration in connection with small field pumping or gas booster plants, or small gasoline plants where the anticipated life is short. It is often impossible to salvage the ordinary spray water cooling tower after just a few years of service.

Generally, except for applications requiring dissipation of heat from high initial levels down to moderate temperatures, the direct air cooling system will lead to relatively high investment costs. There are two fundamental reasons for this. First, under like conditions the transfer of heat from a commodity to a flowing stream of atmospheric air requires a great deal more transfer surface than is required to transfer the same amount of heat to a stream of cooling water. Second, it is not possible at any given location during warm or even average weather to find cooling air at as low a temperature as can be easily attained by the cooling water from the evaporative cooling tower.

The reason for the difference in cooling levels which can be reached economically by the two methods is that a spray cooling tower can cool the water put over it to a close approach to the so-called "wet bulb" temperature at the time and place, whereas the dry air cooler obviously can cool only to a reasonable approach to the "dry bulb" temperature.

It is quite common to design spray water cooling towers to cool the water passed through it to within 5 degrees of the wet bulb temperature, and to design the commodity cooler using such water for an approach of between 5 and 10 degrees to the water temperature. Thus it is entirely practical with a water cooling tower system to cool the commodity to within, say, 12 degrees of the wet bulb temperature, and it may be economical to do better than this in some instances.

With the dry air cooling system it is obvious that the commodity can be cooled only to within some reasonable approach to the dry bulb temperature. As a practical proposition this approach ordinarily cannot be closer than 25 F. Designs for narrower approaches than this will almost always lead to excessive quantities both of exchange surfaces and propelled air.

The difference in practically attainable temperatures between the two systems of cooling does not appear fully until we investigate the difference between wet bulb and dry bulb temperatures at various places. In general it can be said that the difference between the wet bulb and dry bulb temperature at any particular time and place will be greater the lower the relative humidity. In other words there will be comparatively little difference in humid locations and much greater differences in dry areas.

Some figures in this connection are interesting. The data given is taken from a study of U. S. Weather Bureau data which was compiled some years ago by the Marley Company.

The figures given are from the summer weather data, and represent temperatures which will be exceeded not more than 5 percent of the total hours during June to September inclusive of an average summer. The wet bulb temperature for an area ranging through Galveston and Houston up to the corner of East Texas is 79 F., while the dry bulb temperature for approximately the same area is 96 F. Thus on the basis of the practical approach figures given above it would be feasible to cool a commodity to 91 F. (12-degree approach to wet bulb) using a cooling tower system, whereas it would be practical to cool the same commodity only to 121 F. (25-degree approach

to dry bulb) using a dry air cooler. Thus at a location in this general neighborhood the difference between dry and wet cooling would be 121 degrees minus 91 degrees or 30 F.

At the other extreme would be an installation in a hot dry location such as Phoenix, Arizona. At Phoenix the summer wet bulb temperature is 75 F., and consequently it would be feasible to cool commodities to 87 F. with a 12-degree approach. The corresponding dry bulb temperature at Phoenix is 110 F., and consequently with a dry air cooler it would be economical to cool commodities only to 135 F. with a 25-degree approach. Thus at Phoenix the difference between wet and dry cooling would be 135 F. minus 87 degrees or 48 F.

It is obvious from the preceding general analysis of the differences between the two systems of cooling that the decision must rest on a complete study of all of the conditions (including weather) at the proposed plant site.

If no water whatever is available at the plant site, which condition could be encountered very easily in some of the Western states, the decision is forced and there is nothing to do but install dry air cooling, and the gasoline plant must be designed around the cooling temperatures attainable with such cooling.

Sometimes the required level of cooling can be raised by study of the plant process. For example, it may be possible to raise the operating pressure of a fractionating column enough to get the required condenser temperature high enough to make use of dry cooling. Another expedient is to enlarge the secondary recovery system in the plant enough to accommodate the larger volume of uncondensable vapors from the various distilling and fractionating steps.

After exploring these possibilities it may still be impossible to work out an efficient gasoline plant making use of the final temperatures available from dry air cooling. In such cases it is possible to attain any required process temperature by installing a refrigerator cycle which in effect pumps the heat from the temperatures needed in the final cooling of the process up to a refrigerator condenser temperature which can be reached by the dry air cooling. Incidentally we have just lately put into operation a plant using a low temperature refrigeration process where the primary extraction of gasoline is made at a temperature of —5 F., with a corresponding temperature of —15 F. in the refrigerant evaporator. Not a drop of water nor a pound of steam is required for the operation of this plant, in spite of the fact that the summer dry bulb temperature at its location is 96 F.

It is evident that dry cooling can be applied most favorably where the temperature of the commodity to be cooled is highest. For example, one of the best and earliest applications is for the condensation of steam. Even in plants where water supplies are reasonably adequate and low gradient cooling is done by means of a spray tower, dry air steam condensers may often prove economical, since they may be able to handle a large cooling load satisfactorily, and thus correspondingly reduce the duty demanded of the spray tower.

Another nearly ideal application for dry coolers is the common one of gas engine jacket water cooling. With modern high speed engines the recommended jacket water temperature range is often around 150 to 160 F., and dry coolers can satisfactorily handle such cooling.

There are several other cooling duties around a normal gasoline plant where dry coolers may fit in well in combination with usual water cooling towers. For example, the vapor leaving stills and fractionators may be at such levels that a large part of the initial cooling and condensing heat can be removed by dry coolers, thereby relieving the water cooling tower of a large heat load and hence reducing the size of tower and its water circulation.

This arrangement may be particularly valuable in processes where the vapor or other commodity to be cooled issues at an unusually high temperature, say, in the range of 250 to 500 F. In such cases cooling by ordinary water-cooled exchangers will usually produce excessive scaling and perhaps corrosion on the water side.

In some locations reduction in the size of the water cooling tower may result in important reduction of operating costs even where the supply of water is ample. For example, in many locations along the Gulf Coast there is a tendency for algae to form in the cooling tower structure. Such formation clogs the baffles in the cooling tower, and may also increase resistance to the flow of water through heat exchangers on account of accumulation of the algae formed in the cooling tower.

In some locations it may be necessary to apply severe chemical treatment to the circulating water in order to control the growth of algae. Such treatment may require the use of chlorine or other chemicals which may increase corrosion of the metal parts in piping and heat exchangers.

Still another difficulty sometimes encountered in water cooling towers is the phenomenon of delignification. This difficulty occurs where the water supply tends to be alkaline, causing the concentrated cooling tower water to dissolve out the lignin from the wood in the cooling tower structure. The long-time effect of this action is to make the wood fibers tend to separate or "broom out," which of course largely destroys the structural strength of the wood. These effects can be controlled to some degree by chemical treatment of the water, at the hazard of introducing some additional corrosion. Where this phenomenon is a problem the use of supplementary dry cooling may be justified in order to reduce the size of the cooling tower system and hence reduce the operating and maintenance cost of that part of the plant. ##

Meet the Author

J. J. WEATHERBY, with Stearns-Roger Manufacturing Company since 1937, now is its senior sales engineer and process consultant. For eight years, he was the company's chief process engineer. A graduate of Alabama Polytechnical Institute, Weatherby was one time analytical chemist for American Agricultural Chemical Company, ran his own consulting firm, and served Arkansas Fuel Oil Company as a special engineer on gasoline plants.

Computing Cooling Tower Performance

Ease calculations to establish cooling tower performance from routine operating data. Useful assumptions are made to simplify computations.

Maxey Brooke
Old Ocean, Texas

A NUMBER of excellent articles have been written on the design and testing of cooling towers. Most of the calculations given are tedious and difficult. Frequently an engineer must make an estimate of cooling tower performance that does not warrant these lengthy mathematics. A number of useful shortcuts have been devised and are presented in the following examples:

1. Percent Blowdown: This is useful in making material balances around a tower. It shows how much of the make-up water is being wasted by going to the sewer or leaving the tower as windage loss, and how much is being usefully utilized by being evaporated.

$$\text{percent blowdown} = \frac{\text{ppm chlorides in the makeup water} \times 100}{\text{ppm chlorides in the circulating water}}$$

For example, if the chloride concentration of the make-up water is 50 parts per million and if the circulating water is 400 ppm, the percent blowdown is (50 x 100) ÷ 400 = 12.5 percent. In other words, of each 100 gallons of make-up water, 12½ are wasted and 87½ are utilized. Of course, constituents other than chlorides can be used in these calculations.

2. Cycles of Concentration: In a sense, this value is the inverse of the blowdown. It is quite useful in calculating the treatment dosage. The higher its value, the more efficiently the water is being utilized.

$$\text{Cycles} = \frac{\text{ppm chlorides in the circulating water}}{\text{ppm chlorides in the make-up water}}$$

In the above example, the cycles of concentration is 8. If the desired concentration of treatment in the circulating water is 40 ppm, the concentration in the feed water must be 40 ÷ 8 = 5 ppm.

3. Permissible Concentration: The limit to which the circulating water can be concentrated is governed by the hardness value of the water and its pH. Figure 1 shows the hardness values at which precipitation takes place for any given pH value. It is not desirable to carry the hardness of the circulating water higher than 70 percent of the precipitation concentration.

In the example, assume that the water is being carried at a pH of 6.5. From the chart it will be seen that the maximum hardness is 680 ppm. The safe operating value is 0.7 x 680 = 480 ppm.

From Example 2, the cycles of

To estimate . . .

1. **Percent blowdown**
2. **Cycles of concentration**
3. **Permissible concentration.**
4. **Heat load—Evaporation rate.**
5. **Make-up water required.**
6. **Air required—Air temperature.**
7. **Fan horsepower required.**
8. **Cross-section area.**

Data needed . . .

1. **Ppm chlorides in make-up water.**
2. **Ppm chlorides in circulating water.**
3. **pH of circulating water.**
4. **Circulation rate.**
5. **Inlet water temperature.**
6. **Outlet water temperature.**
7. **Wet bulb temperature.**
8. **Dry bulb temperature.**

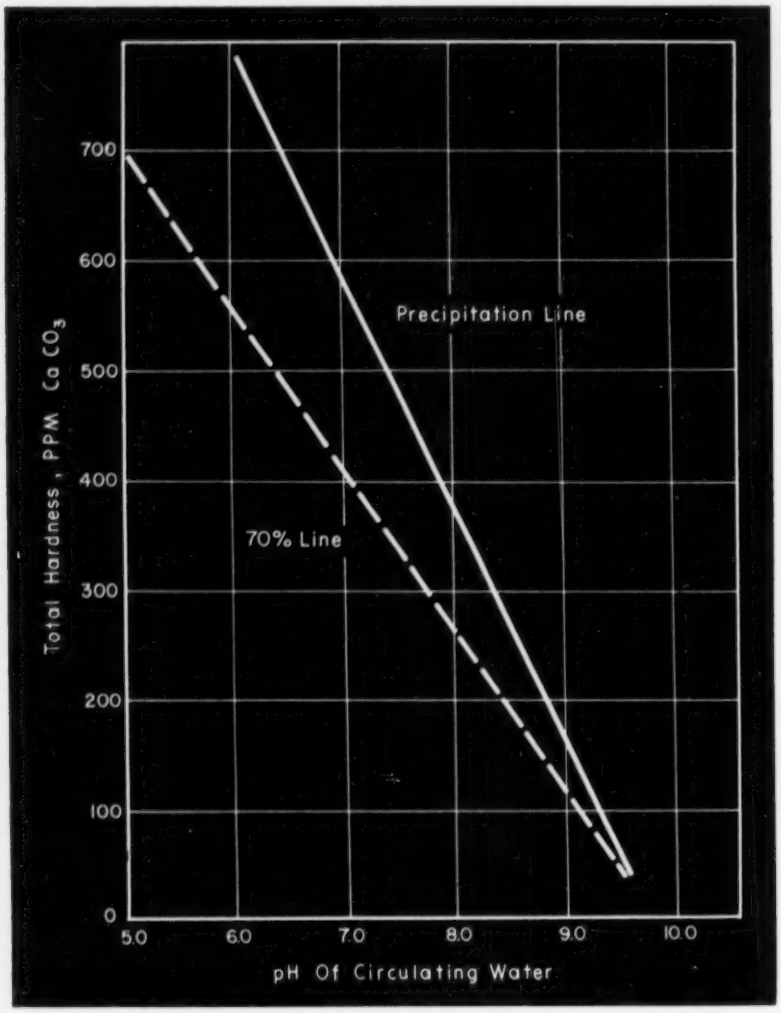

FIGURE 1—Permissible Water Hardness

concentration were found to be 8. Thus 480 ÷ 8 = 60 ppm is the maximum allowable hardness of the make-up water. If the hardness of the make-up water is greater than 60 ppm, it will be necessary to increase the blowdown, reducing the cycles of concentration and the hardness of the circulating water. If the hardness of the make-up water is less than 60 ppm, water and treatment chemicals are being wasted at a concentration of 8 cycles. In this case it is desirable to try to reduce the blowdown.

4. Heat Load. This is the amount of heat dissipated by the tower in a unit length of time. It is based on the fact that 1000 British Thermal Units are required to evaporate one pound of water. The heat of evaporation is furnished by the cooling of the circulating water; 100 pounds of water must be cooled 10 degrees to furnish this amount of heat. Thus the evaporation loss is 1 percent of the tower circulation for each 10-degree temperature drop through the tower, and from this the heat load can be calculated.

Suppose a cooling tower has a circulation rate of 12,000 gallons per minute. The circulating water to the tower is 103 F. and the water leaving the tower is 88 F. The evaporation loss will be $\frac{103-88}{10} \times \frac{12000}{100} =$ 180 gallons per minute.

This is equivalent to 180 x 8.33 = 1500 pounds per minute and the heat load is 1500 x 1000 = 1,500,000 BTU's per minute.

5. Make-up Water Required: This figure is simply the sum of the water evaporated and the water blown down. From Example 4, the evaporation rate was 180 gpm. From Example 1, the percent blowdown was 12.5 percent. Thus the percent evaporated is 100 — 12.5 = 87.5 percent and the make-up becomes 180 ÷ 0.875 = 206 gpm.

6. Air Required: Enough air must be drawn or forced through the tower to evaporate the amount of water shown in Example 4. Two additional measurements are needed; the wet- and dry-bulb temperatures of the inlet air. For calculation purposes, let these be 70 and 85 F., respectively. From a psychrometric table or chart, it will be found that the water content of such air will be 0.0124 pounds of water per pound of dry air.

It has been found that the temperature of the outlet air is very close to the average of the inlet and outlet water temperatures (see Figure 2). The wet and dry bulb temperatures of the outlet air are the same, i.e., it is saturated. From Example 4, the inlet water temperature was 103 F. and the outlet water temperature was 88 F. The average is 95 F. which is assumed to be the outlet air temperature. Again from a psychrometric table or chart, the

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MAXEY BROOKE, following his graduation from the University of Oklahoma in 1935, spent several years in various phases of the oil industry—working as a boomer, driving a truck, serving with pipe-lining and seismograph crews—before he settled down as a chemist, first in a gasoline plant and then a sulphur mine. He served two years in the Army Chemical Corps, and joined Phillips Petroleum Company in 1947 as a water chemist. He now is a supervisory chemist at Phillips' Sweeney, Texas, refinery. A previous contributor to PETROLEUM REFINER, Brooks counts writing as one of his prime outside interests. In addition to technical articles, he has written some fiction.

water content of this air is 0.0367 pounds of water per pound of dry air.

Thus, each pound of dry air will pick up $0.0367 - 0.0124 = 0.0243$ pounds of water vapor. The evaporation rate for the heat load in question is 1500 pounds water per minute. The dry air required to remove this quantity of water is $1500 \div 0.0234 = 61{,}700$ pounds.

7. Fan Horsepower Required: A good rule of the thumb for induced draft cooling towers is that each 8000 cubic feet per minute of air requires one blower horsepower.

In this problem the fans are handling 61,700 pounds of dry air and $0.0367 \times 61{,}700 = 2260$ pounds of water at 95 F. These values can be converted to cubic feet per minute by the following calculation. The molecular weight of air is 29 and of water is 18. Each pound molecular weight will occupy 379 cubic feet at 60 F. At 95 F;

$$379 \times \frac{(460 + 95)}{(460 + 60)} \times \frac{1}{29} = 14.0$$

cubic feet per pound dry air

$$\text{and } 379 \times \frac{(460 + 95)}{(460 + 60)} \times \frac{1}{18} = 22.5$$

cubic feet per pound water vapor.

For 1 pound dry air, volume is 14.0 cubic feet, for 0.0367 pounds water vapor, volume is 0.8 cubic feet, for 1.0367 pounds of mixture, volume is 14.8 cubic feet. The density of the mixture is $1.0367 \div 14.77 = 0.0702$ pounds per cubic feet. The cubic feet per minute is $\frac{61{,}700 + 2260}{0.0702} = 911{,}000$ and the fan horsepower required is $911{,}000 \div 8{,}000 = 114$

8. Cross-section Area of Tower: A rough estimate of the cross section area of an induced draft cooling tower is made by using a water loading of 2.5 gpm per square foot and keeping the air velocity below 350 feet per minute. In this example, the necessary area would be $\frac{12{,}000}{2.5} = 4{,}800$ square feet. The air velocity would be $\frac{911{,}000}{4{,}800} = 190$ feet per minute which is allowable.

For a cross draft tower, water loadings of 4 gpm per square foot are often used.

9. Water Efficiency: The lowest temperature to which water can be cooled by its own evaporation is the wet bulb temperature of the air with which it is in contact. The water efficiency of a cooling tower would be the ratio of the actual cooling to the theoretical cooling:

$$\text{Water efficiency} = \frac{\text{Hot water temp—Cold water temp}}{\text{Hot water temp—Wet bulb temp}}$$

x 100. And in this problem would be $\frac{103-88}{103-70} \times 100 = 46$ percent. This value is rather low. Water efficiencies of 65-70 percent are considered good.

Any steps taken to increase the intimacy and time of contact between the air and water will improve the efficiency.

10. Thermal Efficiency: The only useful function performed by a cooling tower is the dissipation of heat. The media that performs the useful work is the circulating water. Only that water evaporated is useful. Thus, the thermal efficiency of a cooling tower would be the percent of the water supplied to the tower which is evaporated. In this problem the thermal efficiency would be $(180 \div 206) \times 100 = 87.5$ percent. 80 percent thermal efficiency is considered good, 90 percent is excellent and above 90 percent is exceptional.

The thermal efficiency of a tower can be increased in two ways.

- Increase the amount of water evaporated by—
  a. Increasing the temperature differential through the tower.
  b. Changing the tower design to give better air-water contact.
- Decrease the amount of lost water not evaporated by—
  a. Decreasing the windage loss.
  b. Decreasing the leakage loss.
  c. Decreasing the deliberate blow down. # #

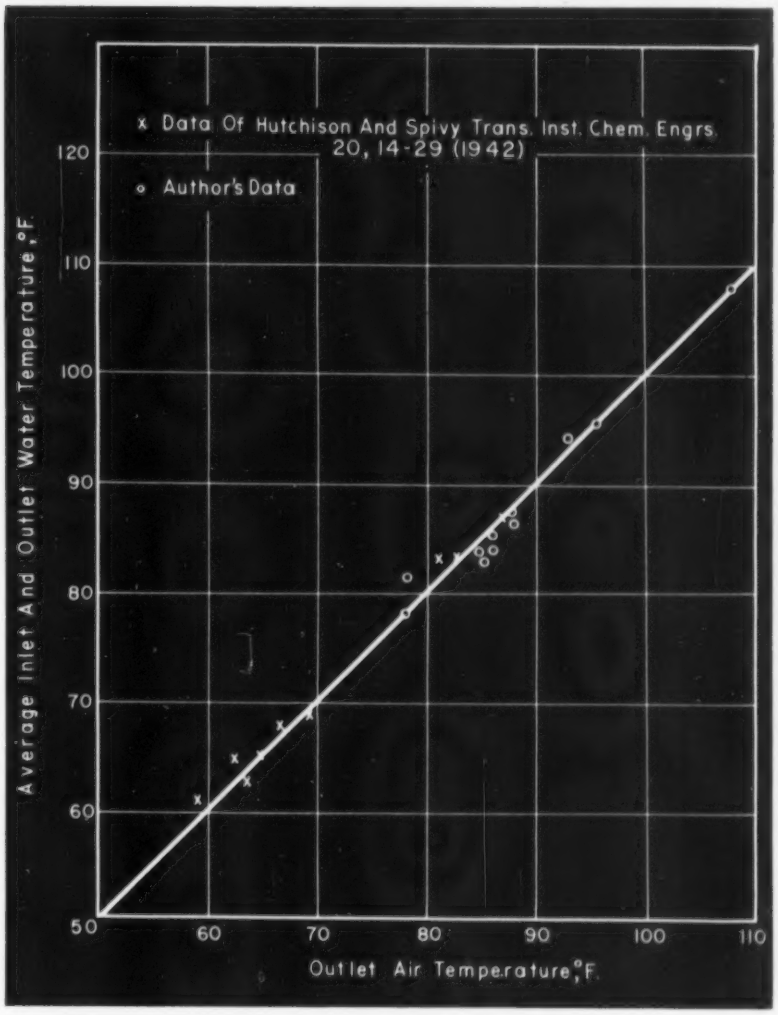

FIGURE 2—Estimate of Outlet Air Temperature

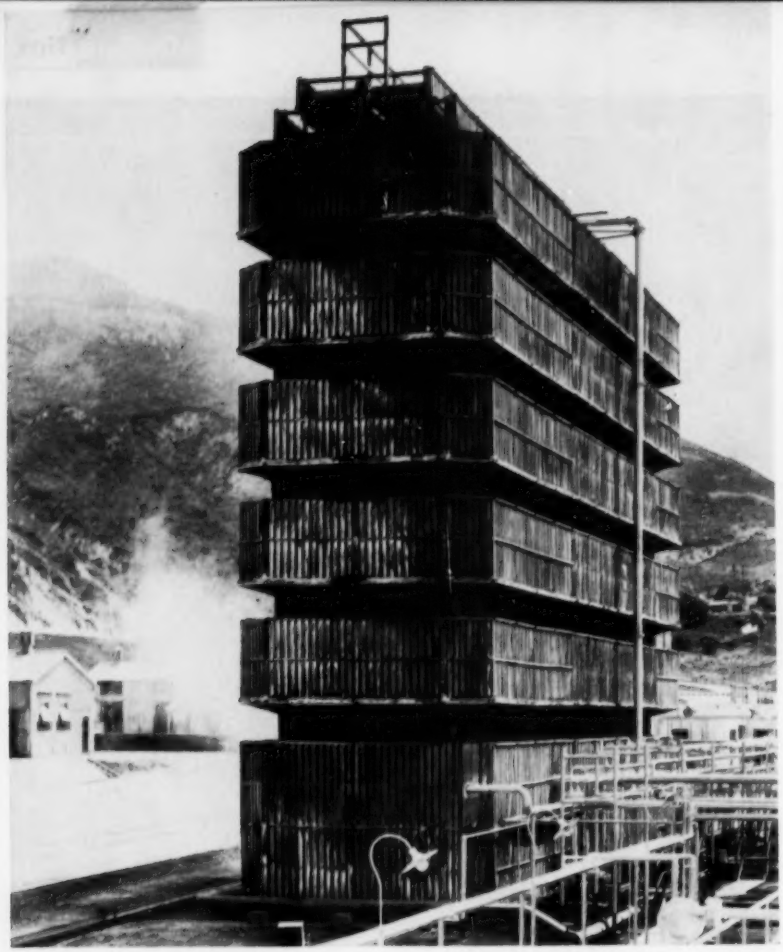

FIGURE 1—Atmospheric tower after 17 years in service.

Revitalize Your Tower

Here are some things to consider to insure getting the most from your old cooling towers.

J. M. Whitesell and Anthony Durando
Fluor Products Company, Whittier, Calif.

IN THE OLDER cooling towers component changes often can be justified on the basis of newer designs and improved performance, before deterioration has set in. Tower conversion should be considered where poor operating conditions, space limitation, or expensive piping changes are involved tending to make the consideration of a new tower installation unattractive. Each tower requiring repair or modification is a separate problem. Only after an economic study of the individual situation can the proper course be determined.

Atmospheric Cooling Tower Conversion—Atmospheric tower repairs covers essentially the replacement in kind or with similar parts as deterioration takes place. It is entirely feasible and practical at times to consider use of the existing frame and convert to a mechanical draft tower.

Atmospheric towers are usually designed for from 3-5 mph wind velocity. These conditions of wind are set at a normally expected minimum velocity so that the plant will be furnished with design cold water temperatures or better most of the time. Atmospheric conditions do fluctuate, however, and it is not uncommon for certain localities to experience near zero wind velocity especially during a shift in wind direction. It is at these times that the cold water temperature may take a sudden rise with a corresponding loss in plant product.

Economic evaluations of product loss as well as operational problems experienced at that time often indicate that converting the atmospheric coilshed tower to mechanical draft is justifiable. This is frequently the case where additional plant capacity is desired as well as the elimination of the fluctuating temperature conditions experienced with atmospheric tower cooling. The factor of eliminating nuisance drift loss accompanies the conversion of atmospheric towers.

The structural members of most cooling towers are generally in sound conditions and can be used with additional bracing as necessary to meet newer local building codes. At times, a portion of the water distribution system can be used as part of the converted unit. If it is a coilshed tower that is being considered for conversion, there will be essentially no changes made in the redistribution system and the coilshed itself. Normally in the coilshed tower conversion, a vapor duct is brought up from the coilshed area to the under side of the fan for expelling vapors coming from the coils. A detailed inspection of the tower will reveal those portions reusable.

A section of the tower distribution system is blocked off during conversion and can proceed in cell unit stages. The plant does suffer a partial cutback in capacity as the first stage proceeds. As each stage is completed, it goes on stream and the product loss is kept to a minimum. In the final stages of completion, the new design conditions are being approached and this frequently is an increase in capacity over cooling loads handled by the

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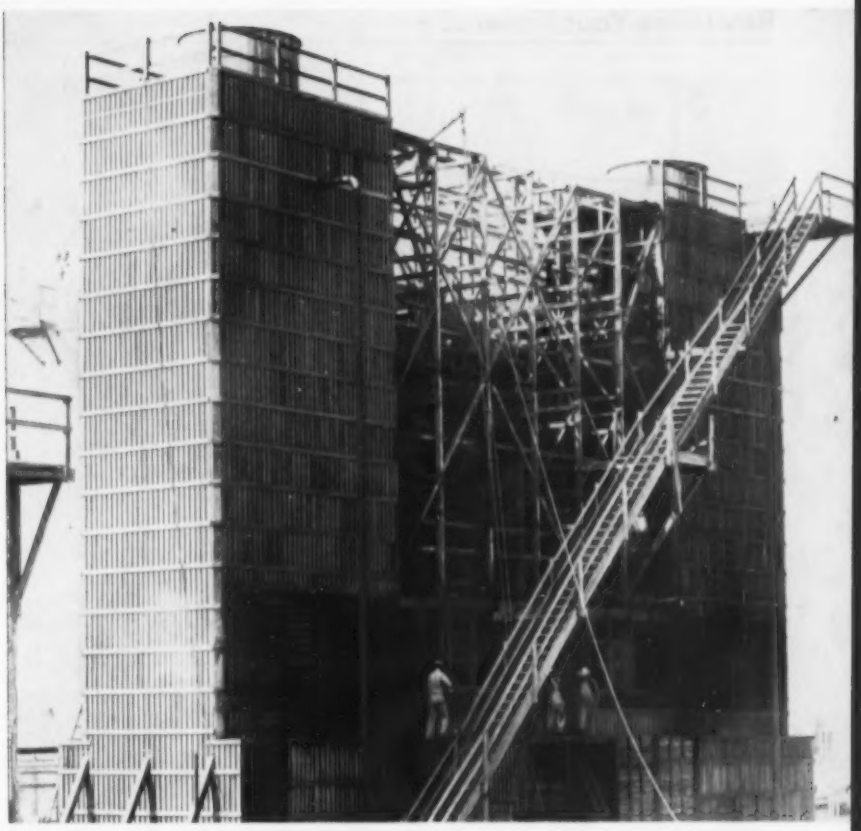

FIGURE 2—Tower in process of conversion from atmospheric to induced draft. The work is done with half the tower in service.

original atmospheric tower.

The conversion of an atmospheric coilshed tower means that the coils, their supports, and the redistribution system may remain undisturbed. This is an expensive item if a new mechanical draft coilshed tower is contemplated on a new location within the plant. Piping to and from coils, as well as water piping is not disturbed in the conversion. When these items are considered, the initial cost of the remodeled unit can be less than a new unit.

Mechanical Draft Tower Conversion—Mechanical draft tower repairs may meet the need for eventual replacement in kind or by a newer and more efficient design. The latter may at times allow increased capacity which should be seriously considered when any major repair is contemplated.

To understand the principles and possibilities in repair and conversion of an older mechanical draft cooling tower, some discussion of tower parts and operation is given. Early mechanical draft cooling towers were essentially low air velocity, high pressure drop, low fan efficiency towers. Further, towers of the forced draft type were difficult to design from the standpoint of controlling the high air inlet velocities as well as the fact that low exit air velocities leaving the entire top of the tower made recirculation a sizable problem.

Early towers were designed for low air velocity because of available fan sizes and efficiencies, high tower pressure drop characteristics, low efficiency drift eliminator designs, and caution brought about by large mechanical draft tower engineering being in its infancy. Drift eliminators were not necessarily new in principle, but had not been extensively studied to achieve low pressure drop as well as good drift removal characteristics.

Decking designs were frequently of the high-pressure drop-splash type depending on large decking area for cooling. The fans were limited in size because there had been no previous need for large air movers except in mine, industrial, and aeronautical work. Cooling tower fans were generally of the low efficiency type and frequently turning at relatively low speeds. Because of these facts, early towers of this type were forced to low air velocities for otherwise the fan horsepower consumption would have been excessive. It was quite common 10-15 years ago for towers to have 300-350 FPM air velocities. Modern design of eliminators, decking, intake louvers, fans, and gears have allowed air velocities to rise up to 400-450 FPM and over. This 15-50 per cent increase in design air rates means more cooling possible in a given box size without an increase in water carryover (drift loss).

A mere increase of horsepower and fan size, speed, or pitch are not normally feasible to accomplish more cooling since small changes in air rate will give horsepower increases approximately as the square of the velocity change. For example, a 20 percent increase in air would require 44 percent more air horsepower even if the fan efficiency remained unchanged. Obviously, there must be other compensating changes made in the old tower in order to significantly improve performance by an increase in air rate.

Component conversion may be clas-

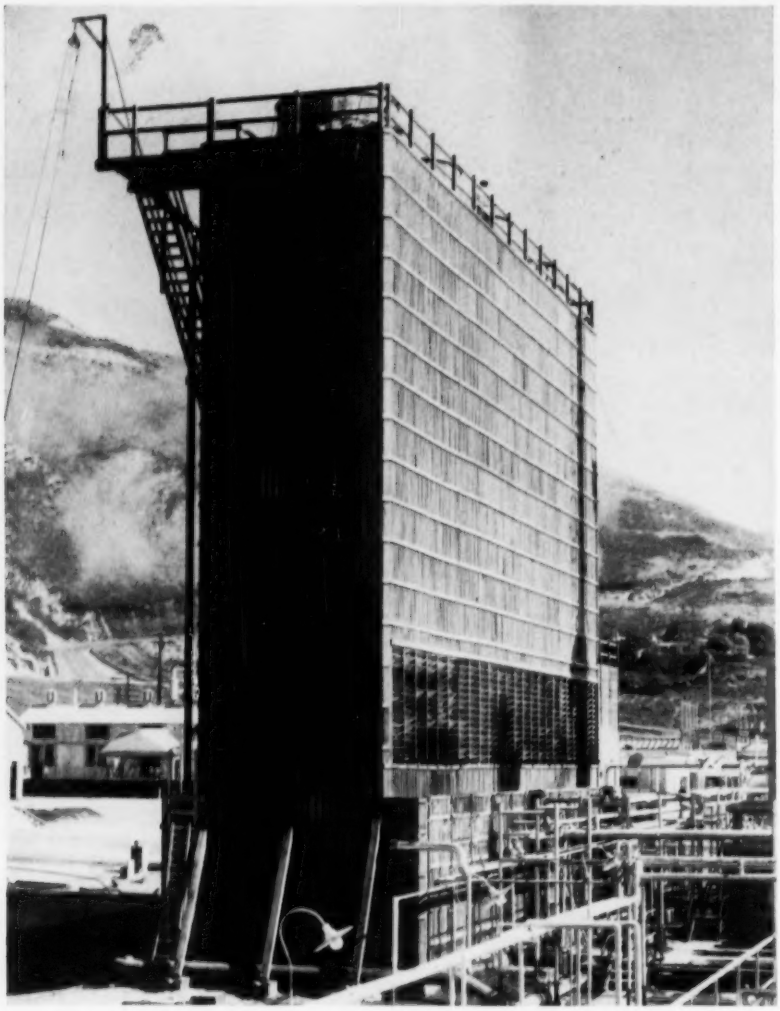

FIGURE 3—Tower in Figure 1 after conversion to induced draft operation.

sified as replacement of cooling tower parts with parts having the same function but possibly having the benefit of newer development and improved characteristics. Each change must be justified on the basis of improvement in performance. Fans may be replaced with models of larger diameter, more blades, and/or higher efficiency.

Occasionally, this can be accomplished with existing motors and gears. Sometimes the motor and gear may be justifiably changed on the basis of more performance. Fan stacks on the induced draft models may on some tower designs be replaced with venturi throat models having lower entrance air pressure drop providing better fan characteristics and more air throughput. Drift eliminators may be changed to newer designs having a fraction of the pressure drop and equal or better drift removal characteristics. Decking can be replaced with lower cost production models having equal or better performance characteristics.

Where replacement deckings may not have higher performance characteristics, they may allow more air movement through the tower and the resultant performance can be better. Intake louvers have frequently been changed on induced draft models to lower pressure drop types providing performance increases. Any one or combination of all these changes may be made to an old cooling tower.

Over-all conversion may be classified as a more radical change resulting in different tower design features and not mere replacement. The conversion of a forced draft tower to an induced draft model is such a change. Here frequently, the amount of recirculation encountered with the low, long forced draft design can justify the modification of the frame with an upward extension to accommodate the fan deck, stack, and mechanical equipment at the top of the tower.

Such conversion can not only reduce fogging and water droplet corrosion of adjacent equipment to a low nuisance level, but can improve performance by reducing the average wet bulb of the air entering the equipment. Another such modification is the addition of short exit stacks at the top of a forced draft tower after a top deck closure has been made.

This modification increases the exit air velocity and divides the exit air into separate jets. The detrimental effect of recirculation is thus reduced. Usually additional horsepower is required to make this conversion unless accompanied by other component conversions.

Component conversions can in general only be estimated as to their effect on performance, unless they include all items in the tower effecting performance (i.e. intake louvers, decking, distribution system, drift eliminators, fan stack, and fan). For example, the change of an old drift eliminator design to a newer design having lower pressure drop and high drift removal characteristics can certainly improve tower performance by allowing more air through the tower, but how much is dependent on the old fan characteristic curve and the decking performance characteristic.

Similarly, the change to a newer fan design and possibly larger motors and gears can only improve the performance of the old tower since more air can be pulled through the box. However, if this is the only change made, the pressure drop characteristic of the old tower is still somewhat unknown and makes it difficult to establish the exact amount of performance increase.

Detailed testing at the tower site could better establish some of these unknowns, however, it is seldom justifiable because of the cost involved. These component changes can in most cases be roughly estimated by experienced personnel. ##

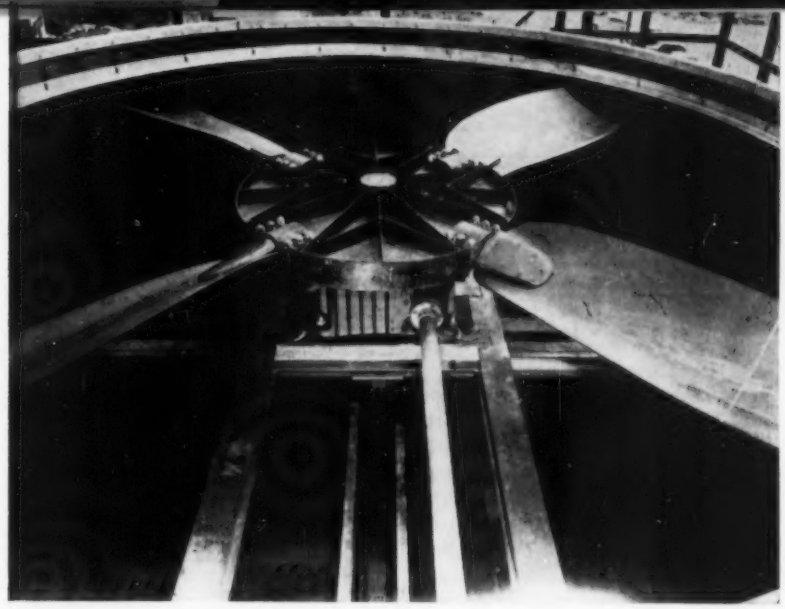

FIGURE 1—Induced draft fan arrangement.

Correct design, proper installation and adequate maintenance—a dollar saving formula for . . .

Cooling Tower Fan Gear Drives

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PROBLEMS ENCOUNTERED in the application of gear reducers as cooling tower fan drives are in many respects unique. To meet the severe operating conditions, this equipment must be specifically designed for the service, properly applied, and adequately maintained.

A typical arrangement of drive equipment for an induced draft tower is shown in Figure 1. The fan, located in a horizontal plane, draws air through the tower structure and exhausts at the top. This blade assembly is mounted directly on the upward extended shaft of a right angle speed reducer. An extended floating shaft coupling connects the gear reducer input shaft to a motor, permitting location of the driver outside of air stream.

This arrangement is a common one used for induced draft towers. The basic setup requires the use of a right angle speed reducer, either worm gear or bevel gear type.

Conditions of power and speed fall within rather well defined limits. The most common driver is a 1750 revolutions per minute induction motor. Fan speeds may be in the range from about 150 to 550 rpm, resulting in a requirement for reduction ratios of from 3:1 to 12:1. Horsepower requirements are from 5 to 75. These figures outline the approximate range of horsepower and speed. Other drivers sometimes used are gasoline engines, steam turbines, and hydraulic motors.

Fan horsepower will vary under the influence of a number of factors. Foremost is velocity, which is of particular importance when a variable speed drive is needed. Power required varies approximately with the cube of fan speed. Blade angle setting also has an appreciable effect on power consumption. Fan blade angles should not be increased without concurrence of the cooling tower manufacturer. Other factors varying with weather conditions are wind velocity and direction and air temperature. Colder and consequently denser air will increase the fan horsepower.

Location in the air stream and exposure to the weather are extremely severe ambient conditions for the gear reducer. Air is exhausted from the tower near the saturation point at temperatures ranging from 75 to 120 F. Exposure of the gear drive to weather can be particularly damaging when the equipment is not operating. Cold starts with ambient conditions well below freezing are common occurrences for winter operation. The fan mounted directly on the gear reducer output shaft imposes loads which are absorbed or transmitted by bearings and gearing. A downward thrust load results from fan weight and aerodynamic reaction. Of even greater severity are loads of variable magnitude which may exist due to unbalance in either the fan itself or the aerodynamic forces acting on the fan. Such aerodynamic unbalance may be caused by inconsistent settings of the angles for individual fan blades or the presence of structural members in the air stream near the suction side of the fan.

To satisfactorily meet these service conditions, certain features must be incorporated in the speed reducer design. Fan shaft bearings should be generously sized to carry unbalanced radial and thrust forces. To back up these bearings rigid case construction, heavily ribbed to resist deflection, is required. Bearings and gearing must be protected against corrosion by shaft seals and a suitable lubrication systems.

Construction of a worm gear speed reducer designed specifically for cooling tower service is shown in Figure 2. In this design, particular attention was directed toward protection of upper bearing on the fan shaft from corrosion. This bearing is located above the lubricant reservoir and is the most vulnerable to corrosion, particularly during shutdowns. A flinger and shaft seal form double protection against entrance of moisture at the top. Lubrication is effected by means of a positive displacement pump which supplies oil through the shaft to this bearing. An additional seal below the bearing forms an oil reservoir which is refilled continuously during operation. When shutdown oil

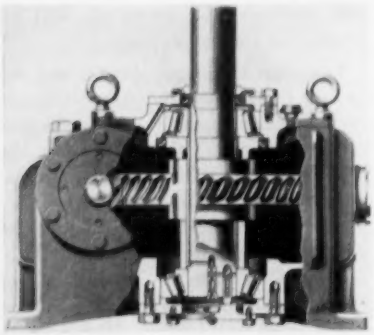

FIGURE 2—Worm gear reducer for cooling tower fan.

is retained around the bearing for protection against corrosion.

An auxiliary drain below the fan shaft lower bearing may be used periodically to drain off the accumulation of water from condensed vapor from the lowest point of the reservoir.

Installation—Proper installation is important to insure proper operation of the equipment. Most cooling towers are of wood construction and therefore subject to change in dimension which may adversely affect alignment of equipment. Particular differences may be noted in the structure between the wet and dry state.

Best practice is to mount gear reducer and driver on common structural steel members. Gear reducers must be bolted to the supporting members with the bolts secured by double nuts or other locking means. After couplings are aligned, the gear unit and drive should be dowelled to the supporting members or fixed in the proper horizontal position by means of jack bolts. This resists the loosening effect of vibration and the twisting effect coming from fan reaction. Alignment may change after water goes on the tower, so it is advisable to recheck within a week after start of operation.

Importance of selecting the proper grade of lubricant can't be over emphasized. Recommendations of the gear manufacturer should always be followed. The lubricant which is correct for one type of gearing may be entirely unsatisfactory for another type. The location of the speed reducer in the saturated air stream makes it advisable to change lubricant every three months.

Checking of oil level in the gear box often does not receive adequate attention. The speed reducer is in a rather inaccessible position and in many cases operation is continuous. One method sometimes used to bring the level indicator and oil fill and drain connections to a more convenient location, is illustrated in Figure 3. However, no matter what type of indicator is used, an accurate check on level can be obtained only after operation has been stopped for several minutes. Such a check should be made at least once a week. At the same time the units should be examined for signs of excessive oil leakage.

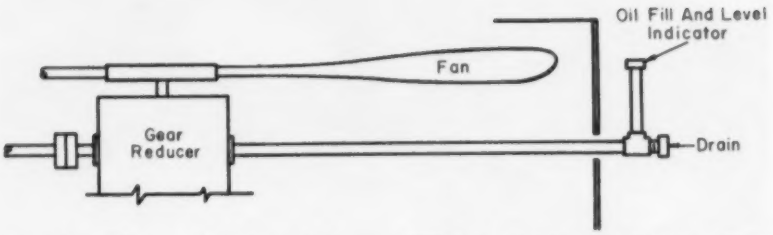

FIGURE 3—Extension level indicator with fill and drain connections.

Operation—Initial operation of the equipment is very critical to subsequent satisfactory performance. The following procedure should be followed:

- Recheck oil level
- Recheck alignment
- Turn fan by hand to make sure there is no binding or interference
- Jog switch to check rotation
- Start operation listening for abnormal noise
- After one week's operation, drain oil, flush reservoir and refill with either filtered oil or new oil. At this time also recheck alignment.

Long periods of shutdown may be responsible for corrosion of internal parts of the gear reducer. Best protection during such periods is to completely fill the unit with oil. Covering the equipment with a tarpaulin will also aid in protecting against the weather. Precaution must be taken to withdraw sufficient oil to restore the proper level before restart of operation. A warning tag attached to the control box can be used as a reminder that oil level must be adjusted. An alternative procedure to filling with oil is to operate the equipment at least once a week to coat internal parts with a film of oil.

Starting operations in winter time should be undertaken only when the lubricant has adequate fluidity to lubricate internal parts. Usual practice is to select an oil for cold operation which has a pour point at least as low as the minimum ambient temperature. In some cases, particularly where operation is essentially continuous, the same lubricant is used the year round. If operation is to start when the ambient temperature is below the pour point of the oil, water is admitted to the tower and permitted to circulate for an hour or so to warm up the lubricant prior to startup.

Maintenance—A definite maintenance schedule can be of great help in preventing troubles from developing. Actual schedules will vary depending on the type of equipment, installation and nature of operation; however, the basic points to be checked are similar.

It pays to take advantage of shutdown periods or regularly scheduled outages to carefully check equipment, make corrections, and replace worn parts. Minor corrections may well prevent a serious failure at a time when loss of cooling capacity cannot be afforded.

The combination of design for the specific application, proper installation and adequate maintenance will result in satisfactory operation of gear reducers in severe service. ##

Meet the Author

JAMES E. GUTZWILLER, now assistant chief engineer in the Standard Products division of De Laval Steam Turbine Company, joined the company in 1941, following his graduation with a degree in mechanical engineering from Rutgers University. Gutzwiller's work with De Laval has included a variety of assignments in the Manufacturing and Engineering divisions.

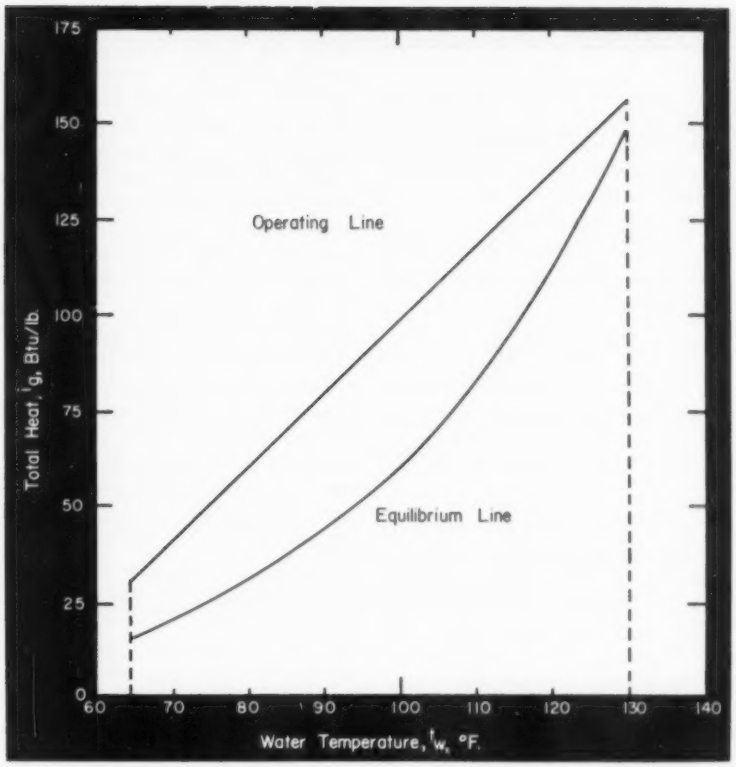

FIGURE 1—The difference between the total heat of the gas and the equilibrium condition may be obtained graphically.

Simplify Gas Cooling Tower Design

A simplification of the enthalpy method is suggested which will make design calculations quicker and easier.

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THE CALCULATION of many gas cooling towers may be carried out in the same way as is in general use for the design of water cooling towers. The principle of this method, which is known as the enthalpy or total heat method, was first proposed by Merkel in 1925.[4]

When the limitations of the enthalpy method are observed, the accuracy is sufficient for most engineering purposes. Furthermore, the graphical or numerical integration of the enthalpy design equation may be replaced by a quicker analytical solution of the enthalpy design equation without undue loss in accuracy.

The design of a heat exchanger generally requires the calculation of the average over-all heat transfer coefficient, as well as the average temperature difference. If in a gas-cooling tower considerable humidification and subsequent dehumidification occurs, the usual logarithmic mean temperature difference will not be equal to the true average temperature difference. Furnas and Newton[2] have nevertheless correlated their extensive experimental data on this basis, because of lack of a better method in those days.

The design of a gas-cooling tower for a non-saturated gas-vapor mixture is further complicated, because the gas may remain non-saturated in the tower so that the heat balance over the tower can not be established in advance. Therefore, the proper cooling water flow rate must be found by trial and error. This condition is especially troublesome when the design of the tower is based on a step to step procedure, because of the time required to calculate through a great number of steps.

Kern[3] has used a step to step procedure for the design of gas-cooling towers, based on the unit of absolute humidity as the driving force for mass transfer. Both mass transfer and sensible heat transfer are calculated from point to point for incremental values of the number of transfer units. This enables the calculation of the cooling water- and gas temperature from point to point.

The author[1] has presented a more general method for the design of gas-cooling towers, in which the path of the gas-vapor mixture is followed by a graphical step by step procedure in a temperature-vapor pressure diagram. This method delivers point to point values for the temperatures of cooling water and gas mixture, and enables the calculation of the area or volume of the tower packing by graphical integration of an equation of the type: $A = \frac{G_m}{h_v} \int_a^e \frac{dq}{t_v - t_w} = \frac{G_m N_{tu}}{h_v}$

Sherwood and Reed[7] have presented a method for the solution of the cooling tower problem by solving three differential equations for heat transfer, mass transfer, and the cooling water temperature. The method enables straight forward calculation of the gas outlet conditions, however its application is rather laborious.

The computation of the most economical dimensions and operating conditions for a gas cooling tower usually requires a series of design calculations involving variations in tower diameter, packing dimensions, gas-liquid ratio, etc. None of the design methods described is too handy for this purpose. Therefore, the accuracy

of the enthalpy design method will be investigated. The method will be compared with the results of the more general design method recently presented by the author.[1]

The enthalpy design method will be used to work an example problem, but first, a short derivation of the equations will be given. The rate of heat and mass transfer, when the liquid film resistance can be neglected, may be expressed as follows:

$$-G_o\, s\, dt = h_g\,(t_g - t_w)\, dA \qquad (1)$$

$$-G_o\, dH = k_x\,(H_g - H_w)\, dA \qquad (2)$$

Equation 2 is an approximation only, because mass transfer is actually proportional to the difference in concentration or partial vapor pressure, rather than to humidity.

An equation for the transfer of latent heat can be obtained from equation 2, by multiplying both sides of the equation by the latent heat of condensation, λ_w. Thus,

$$-G_o\, \lambda_w\, dH = k_x\,(H_g - H_w)\, \lambda_w\, dA \qquad (3)$$

For air-water mixtures, the Lewis relation is approximately correct, or,

$$h_g/k_x = s \qquad (4)$$

Substitution of equation 4 in equation 1 delivers,

$$-G_o\, s\, dt = s\, k_x\,(t_g - t_w)\, dA \qquad (5)$$

Then addition of the equations 3 and 5 delivers an equation for the rate of total heat transfer,

$$-G_o\,(s\, dt + \lambda_w\, dH) = k_x\,(s\, t_g + \lambda_w H_g - s\, t_w - \lambda_w H_w)\, dA \qquad (6)$$

When it can be assumed that the value of the latent heat of condensation, is nearly constant over the temperature ranges involved, or $\lambda_w = \lambda_g$, equation 6 can be written,

$$-G_o\, di_g = k_x\,(i_g - i_w)\, dA \qquad (7)$$

Where, $di_g = s\,dt + \lambda\, dH$

Then integration of this equation over the tower delivers,

$$A = \int dA = \frac{G_o}{k_x} \int \frac{di_g}{i_g - i_w} \qquad (8)$$

This equation is the design equation for the enthalpy method, in which the expression under the integral represents the number of enthalpy transfer units, N_{Ox}. The assumption that k_x is constant is accurate enough for most engineering calculations when variations in the humidity of the gas are relatively small. When the liquid film resistance is appreciable, the gas film coefficient, k_x, may be replaced by the overall coefficient, K_x.

In equation 8, values of i_w can be calculated from,

$$i_w = c_l\,(t_w - t_o) + H_w\,\{\lambda_o + c_v\,(t_w - t_o)\} \qquad (9)$$

Where H_w may be calculated as follows:

$$H_w = \frac{p_w}{(P - p_w)} \cdot \frac{M_v}{M_B} \qquad (10)$$

The values of i_g can be obtained from a simple heat balance, which can be written in its differential form, assuming adiabatic conditions in the tower,

$$L\, c_w\, dt_w = G_o\, di_g \qquad (11)$$

Equation 8 can be solved by graphical integration. This involves plotting $1/(i_g - i_w)$, against i_g and measuring or calculating the area under the curve. There is seldom need to use equations 9 and 11 to calculate intermediate values of i_g and i_w at water temperatures, t_w. Instead, a graphical computation of the value for $i_g - i_w$ can be obtained by plotting i_w against t_w, delivering the equilibrium line, and by plotting i_g against t_w, delivering the operating line. The operating line has a slope equal to Lc_w/G_o, see equation 11. The cooling liquid flow rate, L, is usually taken as constant, which is accurate enough for most practical cases. In those cases, the operating line is straight, see Figure 1.

The limitations to the enthalpy design method depend on the assumptions made during the derivation of the design equation 8.

One limitation is imposed by the assumption that mass transfer is proportional to the difference in humidity, H. This is only approximately correct at relatively low vapor concentrations. When the vapor mole fraction in the gas exceeds values of about 0.15, the deviations may become so great that the enthalpy design method, or the modified enthalpy method should no longer be recommended. Generally, when higher vapor concentrations are involved, it is safer to use the procedure shown in a recent publication.[1]

Also, the value of h_g/k_x should be equal to the humid heat capacity, s. Schmidt[6] has pointed out that this is the case when the quotient of the Prandtl number and the Schmidt number is equal to unity. For air with relatively small concentrations of water vapor, this condition has been found to be nearly correct. For other gas-vapor mixtures, the deviations may be so large that the enthalpy design method can not be applied. In those cases, use can be made of Mizushina and Kotoo's[5] graphical step by step procedure in a diagram of a modified enthalpy against temperature, or the design calculations may be carried out by using the graphical step by step procedure in a partial vapor pressure —temperature diagram.[1]

Further, the enthalpy design method should only be applied when the liquid flow rate, L, is nearly constant, and when there are no great changes in the latent heat of evaporation over the temperature ranges involved, see equations 6 and 9.

When the gas-vapor mixture is in contact with cooling liquid at its wet bulb temperature, $G_o\, di_g = O$, and equations 7 and 8 can not be solved, so that the enthalpy design method becomes unworkable. This case is encountered in some towers when the cooling water is being recirculated.

When the temperature of the cooling liquid approaches the wet bulb temperature of the gas-vapor mixture, the enthalpy design method may deliver results greatly in error. When this occurs at only one end of the tower; however, the accuracy of the enthalpy method in most cases is not seriously decreased. This is a fortunate situation, as in many gas-cooling towers, the temperature of the water leaving the tower at the bottom is near to the wet bulb temperature of the entering hot gases.

Although there are a few limitations to the proper application of the enthalpy design method, there is nevertheless a wide field left where advantage can be taken of its simplicity for the design and calculation of gas-cooling towers. This will be demonstrated by an example.

The example considers a producer gas which enters a scrubber-cooler at 608 F., with a partial water vapor pressure of 0.147 pounds per square inch absolute and a total pressure of 14.7 psia. The gas is to be cooled to 80.0 F., and is to leave the top of the gas-cooler saturated at this temperature. Cooling water enters the top of the tower at 64.4 F., and leaves at the bottom at 130 F.

The composition of the producer gas is as follows:

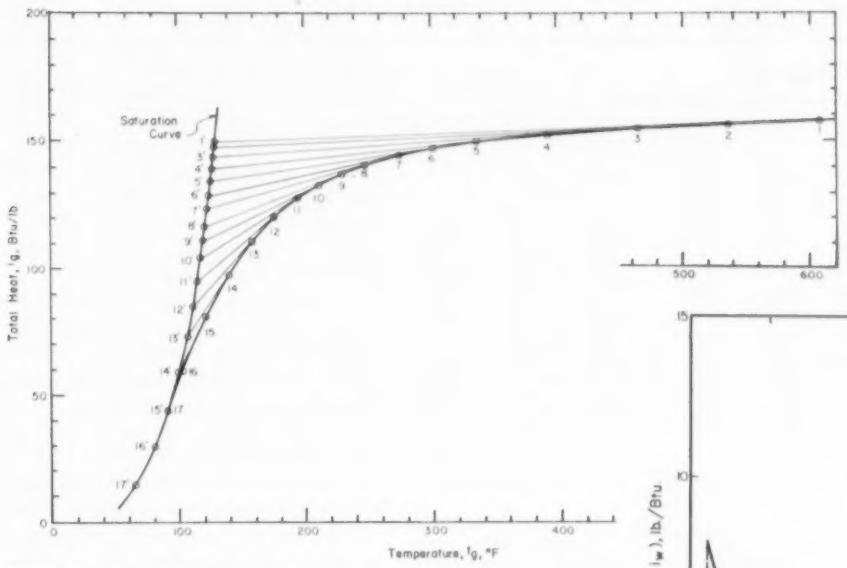


FIGURE 3—The relation of the total heat of a gas to its temperature may be determined by a step to step method.

Component	Vol. %
Nitrogen	57.2
Carbon Monoxide	26.9
Hydrogen	9.3
Carbon Dioxide	5.0
Oxygen	1.0
Methane	0.6

The molecular weight is 26.34, and the calculated average heat capacity over the temperature range involved is 0.271 Btu/lb. F.

To calculate the number of transfer units, necessary for simultaneous heat and mass transfer in the scrubber, we proceed stepwise as follows:

1. Total Heat of Entering and Leaving Gases.

All calculations on total heat will be based on a reference temperature equal to the temperature of the entering cooling water, 64.4 F. The humidity of the entering gas-vapor mixture, H_1, can be calculated with equation 10.

$$H_1 = \frac{.147}{14.553} \times \frac{18}{26.34} = .0069 \text{ lb./lb. dry gas.}$$

The total heat of the entering gases, $(i_g)_1$, at 608 F.,

$(608 - 64.4 \times .271$	$= 147.3$
$.0069 \times 1054.4$	$= 7.3$
$.0069 \times .48 \times (608 - 64.4)$	$= 1.8$
$(i_g)_1$, Btu/lb. dry gas	$= 156.4$

The humidity of the outgoing gases is equal to,

$$H_2 = \frac{.506}{14.194} \times \frac{18}{26.34} = .0243 \text{ lb./lb. dry gas.}$$

The total heat of the leaving gases, $(i_g)_2$, at 80 F.,

$(80 - 64.4) \times .271$	$= 4.22$
$.243 \times 1054.4$	$= 25.60$
$.243 \times .48 \times (80 - 64.4)$	$= .18$
$(i_g)_2$, Btu/lb. dry gas	$= 30.00$

2. Ratio of Liquid and Gas Rates, L/G_o.

The amount of heat transferred to the cooling water is equal to 156.4 — 30.00 = 126.4 Btu/lb. dry gas. The cooling water is heated from 64.4 to 130 F. Thus, the ratio L/G_o is equal to

$$\frac{126.4}{130 - 64.4} = 1.94$$

3. Calculation of the Number of Transfer Units.

Values for i_g have been calculated for various intermediate cooling water temperatures, t_w, see Table 1. Values for the humidity of the producer gas, saturated at t_w, have been calculated from the saturated water vapor pressure, by equation 10.

The value of the total heat of saturated producer gas at t_w, i_w, has been calculated by application of equation 9. The corresponding values for i_g can

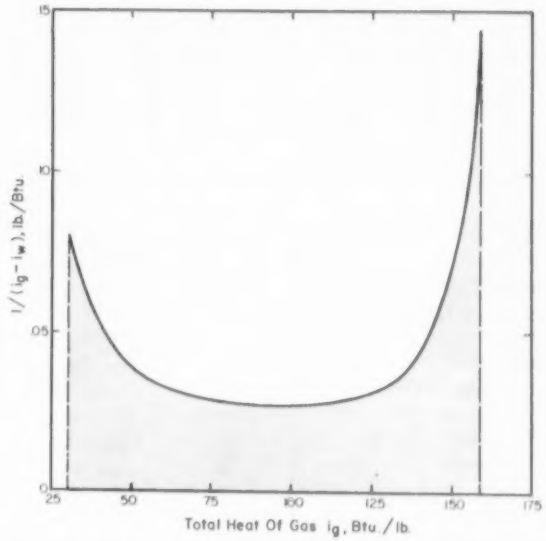


FIGURE 2—The number of transfer units may be found by graphical integration or by multiplying increments as shown in Table 1.

TABLE 1
Calculation of Gas-Cooling Tower by the Enthalpy Design Method

t_w, °F.	i_g, Btu./lb	i_w, Btu./lb	$i_g - i_w$, Btu./lb	$\frac{1}{i_g - i_w}$, lb./Btu	$\left(\frac{1}{i_g - i_w}\right)_{av}$ lb./Btu		Δt_g, Btu./lb		ΔN_{Gx}
130	156.4	149.5	6.9	0.1450					
128	152.5	141.3	11.2	0.0894	0.1172	x	3.9	=	0.458
125	146.7	129.1	17.6	0.0568	0.0731	x	5.8	=	0.424
120	137.1	111.1	26.0	0.0384	0.0476	x	9.6	=	0.458
110	117.8	82.3	35.5	0.0282	0.0333	x	19.3	=	0.643
100	98.5	60.1	38.4	0.0260	0.0271	x	19.3	=	0.523
90	79.2	43.2	36.0	0.0278	0.0269	x	19.3	=	0.520
80	59.9	30.1	29.8	0.0336	0.0307	x	19.3	=	0.592
70	40.6	19.8	20.8	0.0480	0.0408	x	19.3	=	0.787
64.4	30.0	15.0	15.0	0.0666	0.0573	x	10.6	=	0.607
					Total N_{Gx}			=	5.012

TABLE 2
Graphical Solution of the Enthalpy Method

Nr.	t_g °F.	i_g Btu/lb	t_w °F.	i_w Btu/lb	$i_g - i_w$ Btu/lb	$\frac{1}{i_g - i_w}$ lb/Btu	$\left(\frac{1}{i_g - i_w}\right)_{av}$ lb/Btu	Δi_g Btu/lb	ΔN_{Gx}
1.	608	156.40	129.9	149.50	6.90	0.1448			
2.	536	155.34	129.4	147.15	8.19	0.1222	0.1335	x 1.04	= 0.139
3.	464	153.81	128.6	143.75	10.06	0.0995	0.1109	x 1.53	= 0.169
4.	392	151.56	127.4	138.82	12.74	0.0785	0.0890	x 2.25	= 0.200
5.	338	149.04	126.1	133.92	15.12	0.0661	0.0723	x 2.52	= 0.182
6.	302	146.52	124.9	128.52	18.00	0.0556	0.0608	x 2.52	= 0.153
7.	275	143.82	123.4	123.30	20.52	0.0488	0.0522	x 2.70	= 0.141
8.	248	140.13	121.6	116.30	23.83	0.0420	0.0454	x 3.69	= 0.167
9.	230	136.80	119.8	110.61	26.19	0.0382	0.0401	x 3.33	= 0.133
10.	212	132.48	117.6	103.34	29.14	0.0343	0.0363	x 4.32	= 0.157
11.	194	126.95	114.7	94.86	32.09	0.0312	0.0327	x 5.53	= 0.181
12.	176	119.61	110.9	84.55	35.06	0.0286	0.0299	x 7.34	= 0.219
13.	158	110.25	106.2	72.95	37.30	0.0268	0.0277	x 9.36	= 0.259
14.	140	97.20	99.5	59.68	38.12	0.0262	0.0265	x 13.05	= 0.346
15.	122	80.10	90.6	44.19	35.91	0.0278	0.0270	x 17.10	= 0.462
16.	104	59.22	79.8	29.88	29.34	0.0341	0.0316	x 20.88	= 0.648
17.	80	30.00	64.4	15.00	15.06	0.0667	0.0504	x 29.25	= 1.474
								Total N_{Gx}	= 5.030

then be obtained from integrating equation 11, or from a plot of i_g against t_w, see Figure 1. Values of $1/(i_g - i_w)$ are given in Table 1. In Figure 2, the values of $1/(i_g - i_w)$ have been plotted against the corresponding values for i_g. The area under the curve is equal to the number of enthalpy transfer units, N_{Gx}, see equation 8.

Next, the evaluation of the area under the integration curve may be accomplished by multiplying small decrements of i_g, Δi_g, with the average value of $1/(i_g - i_w)$, see Table 1. In this way, it is found that the total number of enthalpy transfer units, N_{Gx}, is equal to 5.01.

A comparison will be made now between this enthalpy method and a temperature-vapor pressure method reported previously.[1] In order to have values of ΔN_{Gx} for both methods over the same temperature intervals, which are directly comparable, the example problem will be reworked. The necessary data are obtained by a graphical solution of the problem in a i-t diagram. (See Figure 3).

Point 1 of Figure 3 represents the temperature and total heat of the entering gas, while point 1′ represents the temperature and total heat of the gas-vapor mixture which is in equilibrium with the cooling water leaving the tower. From the equations 1, 4, and 7, it follows namely that,

$$\left(\frac{di}{dt}\right)_s = \frac{\Delta i}{\Delta t} \qquad (12)$$

Where, $\Delta i = i_g - i_w$, and $\Delta t = t_g - t_w$

Then a straight line between the two points will have a slope equal to $\Delta i/\Delta t$. Such a line, in accordance with equation 12, will indicate the initial trend in the change of the gas-vapor mixture with respect to its temperature and total heat. Thus, this line may be followed over a short distance, delivering point 2.

Next, the difference in total heat between the points 1 and 2 can be read from the diagram. The change in cooling water temperature over this range can then be calculated by application of equation 11, after integration. This delivers point 2′ on the equilibrium line. The same procedure is repeated until the gas outlet temperature is reached. This method delivers the plot of i_g against t_g.

The resulting data are shown in Table 2. The incremental values for ΔN_{Gx} have been calculated by multiplying the decrements of i_g, Δi_g, with the average values of $1/(i_g - i_w)$. The total transfer units calculated in this way amounts to 5.03, against 5.01 as found by the normal application of the total heat design method.

The results of these calculations may now be compared with the results of the identical example worked out previously.[1] The incremental values of the heat transfer units, $\Delta N_{Gh} = \Delta A_{hg}/G_o$, shown in Table 3, is an extension to the data published previously.

In order to compare the total number of heat transfer units, $N_{Gh} = 1.524$, with the total number of enthalpy transfer units, $N_{Gx} = 5.01$, the incremental values of ΔN_{Gh} have been converted to ΔN_{Gx}, by making use of the equation,

$$\Delta N_{Gx} = \Delta N_{Gh}/s_{av} \qquad (13)$$

The average humid heat capacity, s_{av}, has been calculated from average humidity, H_g, per increment.

It can be seen from Table 3 that the total number of transfer units as calculated in this way amounts to $N_{Gx} = 5.15$, against 5.01 as obtained by the application of the enthalpy design method. The deviation is only 2.3%. This agreement is very good.

The agreement between the two figures is a little misleading, however, because it has been found that the deviations between the incremental values obtained by the two methods is much greater. The values of ΔN_{Gx} obtained by the graphical solution of the problem by the enthalpy method are shown again in Table 3 for convenient comparison, together with the percent deviation. A part of the deviations is positive, and a part is negative, in such a way as to make the totals about equal.

The enthalpy design method delivers too high figures at both the top

TABLE 3
Comparison of the Enthalpy Method with the Temperature-Vapor Pressure Method

No.	t_g °F.	H_g lb/lb	$H_{g\,av}$ lb/lb	s_{av} Btu/°F. lb.	ΔN_{Gh}	ΔN_{Gx} Temperature Vapor Pressure Method	ΔN_{Gx} Enthalpy Design Method	Percent Deviation
1.	608	0.0069						
2.	536	0.0223	0.0146	0.278	0.0359	0.129	0.139	+ 7.8
3.	464	0.0376	0.0360	0.285	0.0457	0.161	0.169	+ 5.0
4.	392	0.0528	0.0452	0.293	0.0609	0.208	0.200	− 3.8
5.	338	0.0635	0.0581	0.299	0.0604	0.202	0.182	− 9.8
6.	302	0.0696	0.0666	0.303	0.0515	0.170	0.153	−10.0
7.	275	0.0735	0.0715	0.305	0.0467	0.153	0.141	− 8.0
8.	248	0.0763	0.0749	0.307	0.0571	0.186	0.167	−10.2
9.	230	0.0770	0.0767	0.308	0.0459	0.149	0.133	−10.6
10.	212	0.0770	0.0770	0.308	0.0528	0.171	0.157	− 8.6
11.	194	0.0759	0.0764	0.308	0.0635	0.206	0.181	−12.2
12.	176	0.0734	0.0747	0.307	0.0762	0.252	0.219	−12.7
13.	158	0.0685	0.0709	0.305	0.0945	0.310	0.259	−16.4
14.	140	0.0618	0.0652	0.302	0.1183	0.392	0.346	−11.7
15.	122	0.0525	0.0571	0.298	0.1463	0.492	0.462	− 6.0
16.	104	0.0409	0.0467	0.293	0.1912	0.653	0.648	− 0.9
17.	80	0.0243	0.0326	0.287	0.3775	1.315	1.474	+12.0
Total					1.524	5.149	5.030	− 2.3

and the bottom of the tower, and too low values in between. Since half of the incremental values show deviations between 10 and 16 percent, it is felt that as a general rule, no higher accuracy of the enthalpy design method should be claimed under conditions comparable with those of the design example.

Both methods were used at intermediate points in the tower to determine how much the total heat of the gas-vapor mixture differed from the total heat of the inlet gas, $(i_g)_1 - i_g$. The results are plotted in Figure 4 for the bottom portion of the tower.

It may be concluded that relatively large deviations occur at the bottom of the tower, where the cooling water temperature, t_w, is close to the wet bulb temperature of the entering hot gases. However, the approach of the temperature of the cooling water to the wet bulb temperature of the gas at the bottom of the tower only does not seriously involve the accuracy of the enthalpy method for the calculation of the number of transfer units.

A simple analytical solution may be developed by modifying the enthalpy design method. Walker, Lewis, and McAdams[8], have pointed out that when both the equilibrium line and the operating line are straight in a enthalpy-cooling water temperature diagram, the average enthalpy driving force is equal to the logarithmic mean of the terminal enthalpy potentials. The design equation 8 reduces to:

$$A = \frac{G_o}{k_x} \cdot \frac{(i_g)_1 - (i_g)_2}{\Delta i_m} = \frac{G_o}{k_x} \cdot N_{ox} \qquad (14)$$

$$\text{and, } \Delta i_m = \frac{\Delta i_1 - \Delta i_2}{\ln (\Delta i_1 / \Delta i_2)} \qquad (15)$$

In most industrial gas-cooling towers, the equilibrium line is non-linear, however, due to the fact that the range of cooling water temperatures involved is too great, see Figure 1.

If it were assumed that the equilibrium were a straight line, the analytical solution to the example problem would be as follows:

$$(i_g)_1 - (i_g)_2 = 156.4 - 30.0 = 126.4$$
$$\Delta i_m = 10.43, \text{ since } \Delta i_1 = 6.9$$
$$\text{and } \Delta i_2 = 15.0$$
$$\text{Therefore, } N_{ox} = 126.4/10.43 = 12.1$$

If the cooling water temperature range were divided into two or more sections, the equilibrium lines would be more linear. When we divide the scrubber-cooler into two sections, the following results are obtained:

TABLE 4
Comparing Various Design Methods

Design Method	N_{Ox}	Percent Deviation
1. Temperature-vapor pressure Method	5.15	Basis
2. Enthalpy Method:		
a. Graphical Integration	5.01	— 3
b. Analytical solution:		
1 section	12.10	+135
2 sections	5.90	+ 15
3 sections	5.34	+ 4

1. Cooling water temperatures between 130 and 100 F.

$$(i_g)_1 - (i_g)_2 = 156.4 - 98.5 = 57.9$$
$$\Delta i_m = 18.4, \text{ since } \Delta i_1 = 6.9$$
$$\text{and } \Delta i_2 = 38.4$$
$$\text{Thus, } N_{ox} = 57.9/18.4 = 3.15$$

2. Cooling water temperatures between 100 and 64.4 F.

$$(i_g)_1 - (i_g)_2 = 98.5 - 30.0 = 68.5$$
$$\Delta i_m = 24.9, \text{ since } \Delta i_1 = 38.4$$
$$\text{and } \Delta i_2 = 15.0$$
$$\text{Then, } N_{ox} = 68.5/24.9 = 2.75$$

The total number of transfer units for both sections is $3.15 + 2.75 = 5.90$.

When we divide the scrubber-cooler into three sections, we get the following results:

1. Cooling water temperature between 130 and 110 F.

$$(i_g)_1 - (i_g)_2 = 156.4 - 117.8 = 38.6$$
$$\Delta i_m = 17.5, \text{ since } \Delta i_1 = 6.9$$
$$\text{and } \Delta i_2 = 35.5$$
$$\text{Then, } N_{ox} = 38.6/17.5 = 2.21$$

2. Cooling water temperature between 110 and 90 F.

$$(i_g)_1 - (i_g)_2 = 117.8 - 79.2 = 38.6$$
$$\Delta i_m = 35.75, \text{ since } \Delta i_1 = 35.5$$
$$\text{and } \Delta i_2 = 36.0$$
$$\text{Thus, } N_{ox} = 38.6/35.75 = 1.08$$

3. Cooling water temperature between 90 and 64.4 F.

$$(i_g)_1 - (i_g)_2 = 79.2 - 30.0 = 49.2, \text{ and}$$
$$\Delta i_m = 24.0, \text{ since } \Delta i_1 = 36.0$$
$$\text{and } \Delta i_2 = 15.0$$
$$\text{Thus, } N_{ox} = 49.2/24.0 = 2.05$$

The total number of transfer units for the three sections is then $2.21 + 1.08 + 2.05 = 5.34$.

The results obtained by application of the three methods are compared in Table 4. It is concluded that the analytical design method in sections can deliver quick solutions with sufficient accuracy for engineering design calculations, provided the conditions are such that the enthalpy design method may be used for scrubber-coolers. It is evident that the analytical method is reliable when the cooling water temperature range involved is not more than about 20 F. per section in this example. It has been found that the analytical solution in sections is considerably quicker than the graphical integration, because less intermediate points are to be calculated.

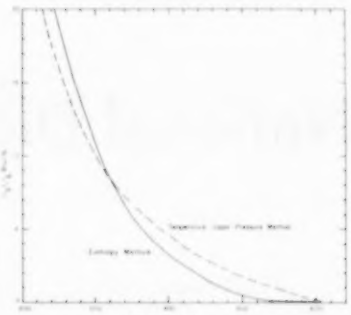


FIGURE 4—Although the two methods differ at intermediate points, the total number of transfer units by either method is about the same.

SYMBOLS USED

- A = Area, square foot.
- c = Heat capacity at constant pressure, Btu/lb. F.
- G_o = Flow rate of vapor-free gas, lb./hr.
- H = Humidity, lb. of vapor per lb. of vapor-free gas.
- h_g = Heat transfer coefficient, Btu/hr. sq. ft. F.
- i = Total heat, Btu/lb. of vapor-free gas.
- $\Delta i = i_g - i_w$, Btu/lb. of vapor-free gas.
- Δi_m = Logarithmic mean total heat difference (see eq. 15), Btu/lb. of vapor-free gas.
- k_x = Mass transfer coefficient, lb./hr. sq. ft. per unit of humidity.
- L = Flow rate of liquid, lb./hr.
- M = Molecular weight.
- M_B = Molecular weight of inert gas.
- N_{oh} = Number of transfer units based on the heat transfer coefficient h_g.
- N_{ox} = Number of transfer units based on the total heat transfer coefficient k_x.
- P = Total pressure of gas-vapor mixture, lb./sq. in.
- p = Partial pressure, lb./sq. in.
- s = Humid heat capacity of the gas-vapor mixture, Btu/F. per lb. of vapor-free gas.
- t = Temperature, F.
- t_o = Reference temperature, F.
- Δt = Temperature difference between the bulk of the gas-vapor mixture and the gas-liquid interface, $t_g - t_w$, F.
- λ = Latent heat of condensation, Btu/lb.

SUBSCRIPTS

- v = Vapor in gas-vapor mixture.
- g = Gas-vapor mixture.
- w = Cooling liquid.
- 1 = Entering gas.
- 2 = Leaving gas.

LITERATURE CITED

[1] Bras, G. H. P., Chem. Eng., 61, No. 12, 191 (1954); 62, No. 1, 195 (1955).
[2] Furnas, C. C., and Nedton, R. H., Chem. Met. Eng., 40, 301 (June, 1933).
[3] Kern, D. Q., "Process Heat Transfer," 615, McGraw-Hill Book Company, Inc., New York, 1950.
[4] Merkel, F., Forsch. Arb. Ing. Wes., Heft 275 (1925).
[5] Mizushina, T., and Kotoo, T., Chem. Eng. (Japan) 13, 75 (1949).
[6] Schmidt, E., Gesundh. Ing., 52, 525 (1929).
[7] Sherwood, T. K., and Reed, C. E., "Applied Mathematics in Chemical Engineering," 134, McGraw-Hill Book Company, Inc., New York, 1939.
[8] Walker, W. H., Lewis, W. K., McAdams, W. H., and Gilliland, E. R., "Principles of Chemical Engineering," 480, McGraw-Hill Book Company, Inc., New York, 1937.

National Diesel Fuel Survey-1955

The Bureau of Mines and the American Petroleum Institute get together to report the properties of diesel fuel for last year.

TESTS WERE made on 312 samples of diesel fuel from 104 refineries throughout the country. They represented 46 petroleum refining companies. The analyses were made by the manufacturer and the results were sent to the Bureau of Mines for compilation and study.

The results of the survey are reported in a release from the Bureau of Mines of the Department of Interior. The report, issued as Information Circular 7737, is entitled "National Annual Diesel-Fuel Survey, 1955" and is the result of a cooperative agreement between the Bureau and the Americal Petroleum Institute.

Two of the summary tables from the report are shown here. They give the results of the tests on grades 1-D and 2-D fuels. The survey also included grades 2-D with a minimum pour point of 5 F and 5-D fuels. Because of the small number of samples, these latter two grades are not reported here. ##

Grade 1-D Fuels

Geographic Location	Eastern			Southern			Central			Rocky Mountain			Western		
Number of Fuels	63			24			95			41			14		
Test	Min.	Average	Max.	Min.	Average	Max.	Min.	Average	Max.	Min.	Average	Max.	Min.	Average	Max.
Gravity, °A.P.I.	25.7	40.9	48.4	33.3	40.5	44.6	25.7	39.9	45.7	33.0	40.5	45.1	37.4	40.9	43.8
Flash point, PMCC	114	...	220	130	...	188	125	...	220	117	...	210	132	...	170
A.S.T.M.—Color	1	...	2½	1	...	2½	1	...	5	1	...	1½	1	...	2
Saybolt—Color	30	...	−5	30	...	1	30	...	−5	30	...	1	30	...	1
Viscosity at 100° F.:															
Kinematic, CS	1.40	2.02	3.17	1.49	1.96	2.79	1.49	2.18	3.34	1.47	2.15	3.34	1.47	1.96	3.02
SUS	30.4	32.7	36.6		32.5	35.4		33.3	37.1		33.2	37.1		32.5	36.1
Cloud, °F.	−60	...	12	−48	...	5	−60	...	8	−50	...	10	−56	...	0
Pour, °F.	−70	...	5	−55	...	0	−70	...	5	−60	...	0	−65	...	−5
Sulfur, %	0.027	0.127	0.478	0.016	0.115	0.46	0.016	0.176	0.497	0.018	0.196	0.50	0.01	0.198	0.50
Aniline point, °F.	102.0	149.4	168.8	135	147.8	164	102.0	140.8	166	117	150.1	166	134.5	149.4	161
Ramsbottom carbon, % on 10%	0.00	0.074	0.15	0.00	0.065	0.13	0.008	0.079	0.152	0.004	0.070	0.12	0.01	0.061	0.09
Ash, %	0.000	0.000	0.008	0.000	0.000	0.001	0.000	0.000	0.004	0.000	0.000	0.002	0.000	0.001	0.002
Cetane number	42.5	51.3	60.0	45.0	50.0	58	40.6	50.9	58.5	43.8	51.1	57	46	49.5	53
IBP, °F.	314	356	435	330	355	402	320	362	453	330	365	453	334	361	396
10%	354	401	489	355	399	450	350	407	491	350	409	491	370	403	442
50%	392	454	537	415	451	524	394	464	537	394	460	522	409	448	522
90%	453	521	591	468	517	588	457	532	592	462	524	584	465	504	584
End point	502	567	625	502	557	622	501	575	625	496	570	625	496	548	625

Grade 2-D Fuels

Geographic Location	Eastern			Southern			Central			Rocky Mountain			Western		
Number of Fuels	50			29			43			19			18		
Test	Min.	Average	Max.	Min.	Average	Max.	Min.	Average	Max.	Min.	Average	Max.	Min.	Average	Max.
Gravity, °A.P.I.	17.6	36.3	44.8	17.6	35.3	39.7	17.6	36.1	40.6	22.9	35.8	38.8	22.9	33.7	38.8
Flash point, PMCC	126	...	240	140	...	240	146	...	240	150	...	198	154	...	210
A.S.T.M.—Color	1	...	4½	1	...	4½	1	...	4½	1	...	3½	1	...	4½
Viscosity at 100° F.:															
Kinematic, CS	2.09	2.74	4.39	2.30	2.93	4.39	2.10	2.95	5.51	2.13	2.86	3.30	2.13	3.10	3.95
SUS	33.0	35.2	40.4	33.7	35.8	40.4	33.0	35.9	44	33.1	35.6	37.0	33.1	36.4	39.0
Cloud, °F.	−12	...	22	−5	...	14	−50	...	16	−22	...	14	−22	...	10
Pour, °F.	−40	...	0	−15	...	0	−85	...	0	−30	...	0	−30	...	0
Sulfur, %	0.03	0.275	0.70	0.05	0.297	0.78	0.059	0.293	0.78	0.12	0.467	0.97	0.28	0.533	0.97
Aniline point, °F.	62.0	147.6	175.6	62.0	146.4	169	62.0	150.2	169.5	70	144.9	162.5	70	138.8	149.0
Ramsbottom carbon, % on 10%	0.01	0.113	0.34	0.01	0.109	0.29	0.04	0.110	0.29	0.002	0.092	0.20	0.06	0.105	0.20
Ash, %	0.000	0.001	0.006	0.000	0.001	0.006	0.000	0.001	0.005	0.000	0.002	0.006	0.000	0.001	0.006
Cetane number	43	50.5	60	45.0	50.3	58	40	50.9	58	45	49.8	54.6	41	45.4	51.4
IBP, °F.	318	367	472	327	376	472	330	372	472	346	384	427	350	379	427
10%	372	432	506	410	439	506	389	438	506	398	438	472	409	444	470
50%	461	507	552	468	512	580	482	514	580	471	502	530	471	511	542
90%	556	590	648	569	592	648	565	596	648	529	586	623	529	597	626
End point	626	646	700	627	650	700	626	652	770	626	648	704	630	663	704

Here's the first complete story on the newest petrochemical . . .

Hydrogen Peroxide

PRODUCTION: From propylene by liquid-phase oxidation, with oxygen, of isopropyl alcohol. From air and hydrogen by catalytic reduction followed by oxidation of hydroquinone.

REACTIONS: As peroxides or peracids in organic synthesis. The greatest promise is in carbon-carbon double bond reactions to form oxiranes and/or glycols.

USES: Epoxy compounds form excellent stabilizers, plasticizers, insecticides, lubricants, lubricant additives, surface active agents, etc.

Lewis F. Hatch
University of Texas, Austin

ALTHOUGH KNOWN since 1818 and commercially available for many years, hydrogen peroxide (H_2O_2) is the most recent compound to become a petrochemical. It has joined the family through its projected preparation from isopropyl alcohol, and it has also recently been recognized as a potent reagent for synthesis from olefins. There are several reasons why hydrogen peroxide was so long in gaining its rightful place in petrochemistry. As with many a wayward son, hydrogen peroxide has received a bad name because of its past instability.

In spite of its reputation, hydrogen peroxide is one of the few inorganic chemicals which has undergone a rapid production increase within the last several years (Figure 1). The developments leading to this production increase have been many fold and include production from organic compounds and its concentration and purification to a point where it is more pure by at least 0.16 percent than a well known soap. It has also been shown that pure hydrogen peroxide is not inherently an unstable compound although it is a very reactive one. In the proper environment it can be safely handled at any concentration.

The availability of high concentration, pure hydrogen peroxide at a reasonable price has stimulated research and utilization of this versatile compound as an oxidation agent, especially for epoxidation and hydroxylation reactions. These reactions are potentially of great interest to petrochemistry, for, by a simple reaction, a carbon-carbon double bond can be changed to an oxirane (α-epoxy, $-\overset{O}{\overset{/\backslash}{C}}-C-$) structure or to a dihydroxy (α-glycol, $-COH-COH-$) structure. The glycol probably results from ring opening of the intermediate epoxide.

Epoxidation. $-C=C- + H_2O_2 \rightarrow -\overset{O}{\overset{/\backslash}{C}}-C- + H_2O$

Hydroxylation. $-C=C- + H_2O_2 \rightarrow -\overset{O}{\overset{/\backslash}{C}}-C- + H_2O$

$-\overset{O}{\overset{/\backslash}{C}}-C- + H_2O \rightarrow -\overset{OH}{C}-\overset{OH}{C}-$

Hydrogen peroxide has other valuable organic reactions which include quinone formation, ring splitting, polymerization and peroxidation. These reactions are used in the production of waxes, resins, polymers, plasticizers, drugs and medicinals, insecticides and many organic intermediates. It is by all of these reactions that hydrogen peroxide will grow in importance in petrochemistry.

Production—Hydrogen peroxide may be formed by a wide variety of organic and inorganic reactions. Most of these reactions have been seriously considered for commercial exploitation, but only a very few are currently used.

For many years hydrogen peroxide was prepared as a 6 to 8 percent solution by the reaction between *barium peroxide* and an acid, usually 70 percent sulfuric acid plus a few percent of phosphoric or hydrochloric acid.

$$BaO_2 + H_2SO_4 \rightarrow BaSO_4 + H_2O_2$$

This process is reported to be used by only one company in the U. S. (Westvaco Company, Division of Food Machinery & Chemical Company) and accounts for less than 10 percent of the annual production.

Essentially all of the current production of hydrogen peroxide comes from *electrolytic processes* which involve

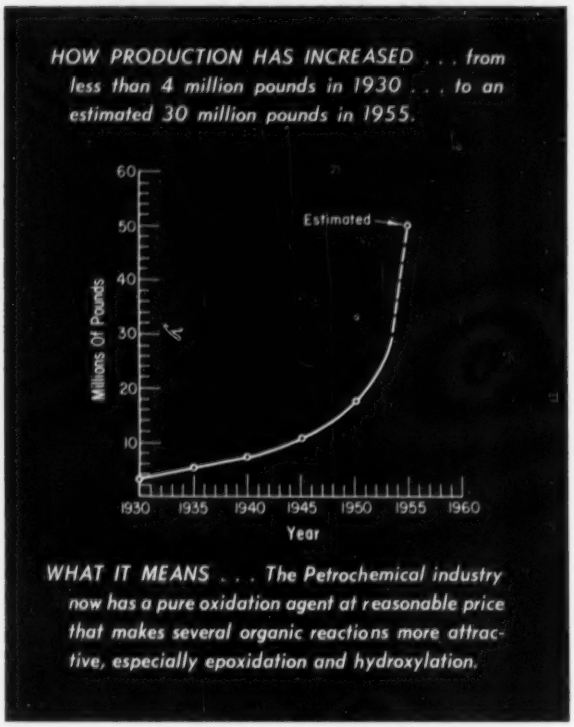

HOW PRODUCTION HAS INCREASED . . . from less than 4 million pounds in 1930 . . . to an estimated 30 million pounds in 1955.
Millions Of Pounds
60
50
40
30
20
10
Estimated
1930
1935
1940
1945
1950
1955
1960
Year
WHAT IT MEANS . . . The Petrochemical industry now has a pure oxidation agent at reasonable price that makes several organic reactions more attractive, especially epoxidation and hydroxylation.

FIGURE 1—Production of hydrogen peroxide (100 percent).

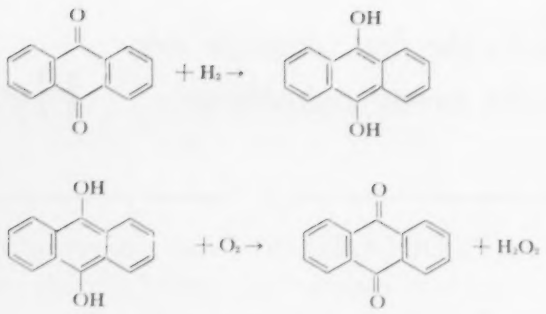
the electrochemical formulation of peroxysulfuric acid or its ammonium salt followed by hydrolysis to hydrogen peroxide and sulfuric acid or ammonium bisulfate.

Cell reaction. $2H_2SO_4 \rightarrow H_2S_2O_8 + H_2$

Hydrolysis. $H_2S_2O_8 + 2H_2O \rightarrow 2H_2SO_4 + H_2O_2$

The advantages of the electrolytic processes are in the production of a hydrogen peroxide of higher concentration (35 percent hydrogen peroxide by weight) and of greater purity and stability. The disadvantages are high capital investment and electricity requirements and the chemicals and electrolytes used must be of high purity.

The first modern *nonelectrolytic* hydrogen peroxide plant in the U. S. has been in operation since 1953 (E. I. du Pont de Nemours & Company). Four other companies (Becco Chemical Division, Food Machinery and Chemical Corporation; Allied Chemical and Dye Corporation; Columbia-Southern Chemical Corporation; Shell Chemical Corporation) are actively in the field with plants either recently completed or under construction. With the exception of Shell Chemical, all the processes appear to involve the initial reduction of an organic compound of the anthraquinone type to the hydroquinone. The hydroquinone is catalytically oxidized by either air or oxygen to form hydrogen peroxide and the original quinone. The over-all result is the formation of hydrogen peroxide from hydrogen and oxygen.



Very little reliable information is available in respect to process variables such as the nature of the organic starting material, solvent, catalyst and method of oxidation. The principal advantage of nonelectric hydrogen peroxide lies in the appreciably lower capital cost of the plant. There is also a distinct saving in simpler plant operation. These savings will be reflected in the cost of hydrogen peroxide when these plants get into full operation.

Shell Chemical has a 30 million pound per year plant scheduled for completion in 1956. This plant will use a process involving the liquid-phase oxidation of isopropyl alcohol (isopropanol) with oxygen at above atmospheric pressure and in a temperature range of 90 to 140 C.

$$CH_3\underset{\displaystyle OH}{\underset{|}{C}}HCH_3 + O_2 \rightarrow CH_3\overset{\displaystyle O}{\overset{\|}{C}}CH_3 + H_2O_2$$

The yield of hydrogen peroxide is almost quantitative and the process produces acetone as a byproduct in a theoretical ratio of 1.7 pounds of acetone for every 1 pound of hydrogen peroxide. This would amount to approximately 50 million pounds of acetone per year. With the acetone market already sensitive because of byproduct acetone from the phenol-from-cumene process, this may be a mixed blessing. Shell's hydrogen peroxide is scheduled to go into its new process for the production of glycerol from acrolein (Figure 2).

The simple production of hydrogen peroxide is not the final answer. The hydrogen peroxide must be concentrated, purified, and stabilized. An important milestone in the concentration of hydrogen peroxide was reached in 1946 when 90 percent peroxide was first marketed, and the ultimate was reached in 1955 with the announcement by Becco of 99.6 percent hydrogen peroxide. This essentially 100 percent peroxide is produced by continuous fractional crystallization starting with 90 percent hydrogen peroxide. The 90 percent peroxide is obtained by distillation and rectification.

This concentration process also removes essentially all of the impurities in the hydrogen peroxide. This is important, for the stability of hydrogen peroxide depends upon the degree to which it has been purified. The various factors which seem to influence its decomposition are (1) temperature, (2) traces of certain cations, especially those of more than one valence, (3) certain active surfaces, especially rough surfaces, (4) suspended matter such as dust particles, (5) hydrogen ion concentration and (6) radiation.

Although there are many things which may cause decomposition of hydrogen peroxide, it is a very stable

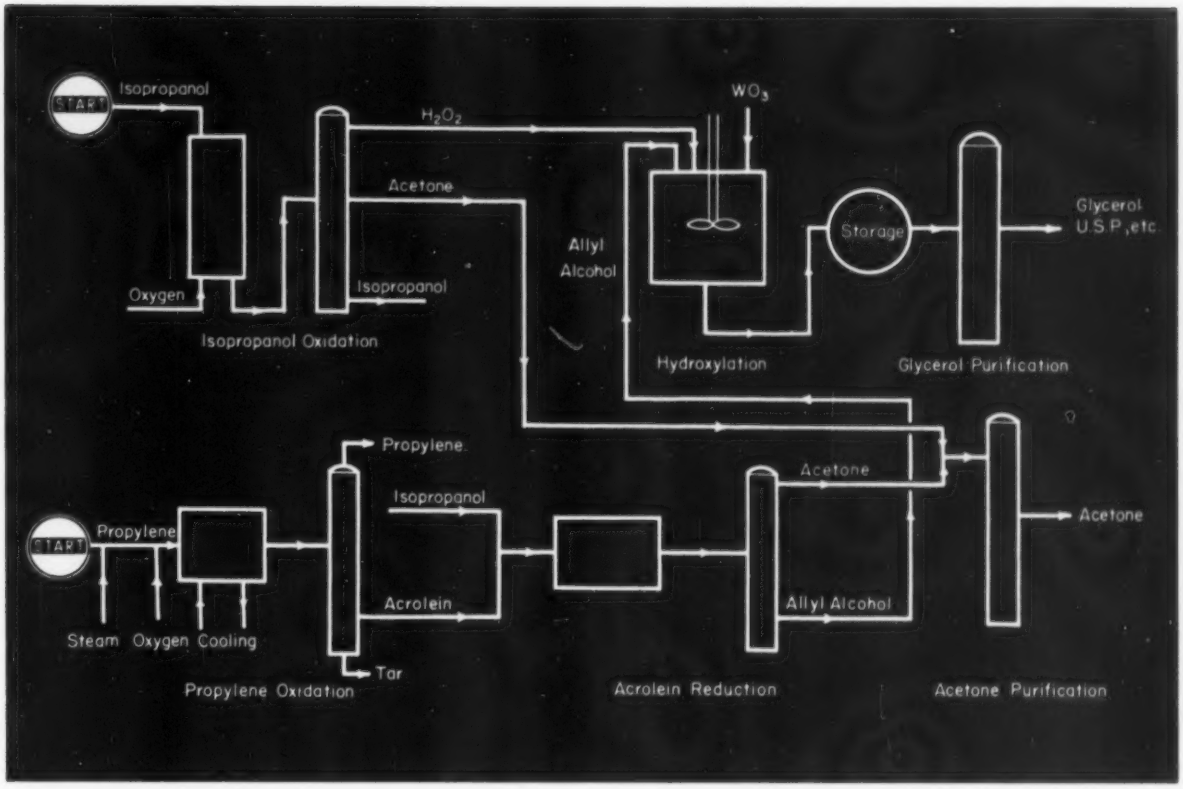


FIGURE 2—Glycerol from hydrogen peroxide and Acrolein.

substance if it is pure, free from contamination catalysts, and in a thoroughly clean container of noncatalytic material. Because these are not readily obtainable conditions, decomposition is controlled during storage and use by the addition of stabilizers and by control of its environment. The three stabilizers most frequently used are sodium stannate or 8-hydroxyquinoline ("oxine") in the presence of a soluble pyrophosphate or a phosphate-pyrophosphate mixture. The use of stabilizers is constantly decreasing as the purity of hydrogen peroxide is increasing. Hydrogen peroxide is transported and stored in high-purity aluminum.

The general technology of hydrogen peroxide, especially in respect to its production, has been reviewed in a book by Schumb, Satterfield and Wentworth ("Hydrogen Peroxide," Reinhold Publishing Corporation, New York, 1955).

Reactions—The most important area opened by the availability of highly concentrated, high purity hydrogen peroxide is in organic synthesis. In many of its uses, however, hydrogen peroxide is not the active agent, for it frequently reacts in the reaction mixture to form organic peroxides or peracids (peroxyacids, RCO_3H) and these are the reactive compounds. Thus the reactions of peracids and other peroxy compounds are of considerable interest in hydrogen peroxide chemistry. Swern has published a comprehensive review of peracids in Chemical Reviews (**45**, 1 (1949)).

The Becco Chemical Division has listed (Bulletin No. 69) the following advantages to the use of hydrogen peroxide either alone or through the medium or peracids as an oxidant in organic synthesis.

- High reaction efficiency (often quantitative yields)
- Ease of reaction control
- High reaction specificity
- Ease of isolation of reaction products
- Products of low residual unsaturation readily attainable
- Minimum byproduct formation
- Use of only slightly higher than stoichiometric amounts of peracid or hydrogen peroxide
- Absence of metallic or other contamination
- General solubility in the reaction medium
- Applicability in aqueous and non-aqueous systems
- Application in heterogeneous as well as homogeneous systems
- Application to standard-type process equipment (glass-lined or series 310 stainless steel).

The hydrogen peroxide reaction with carbon-carbon double bonds to form oxiranes (epoxidation) and/or glycols (hydroxylation) is the one with the greatest promise. A typical procedure would be the addition of hydrogen peroxide to a solution of the olefin in acetic acid with a strong acid catalyst at 60-70 C. The hydro-

gen peroxide reacts with the acetic acid to form an equilibrium mixture of acetic acid, hydrogen peroxide, peracetic acid and water.

$$CH_3C(=O)OH + H_2O_2 \underset{}{\overset{H^+}{\rightleftharpoons}} CH_3C(=O)OOH + H_2O$$

The peracetic acid reacts with the olefin to form an oxirane, and the equilibrium is shifted to the right.

$$-C{=}C- + CH_3C(=O)OOH \rightarrow -C(O)C- + CH_3C(=O)OH$$

This in-situ process for epoxidation uses conditions that favor peracid formation, and these are also suitable conditions for the opening of the epoxide ring. Because of this, the epoxidation reaction is frequently carried out using preformed peracetic acid. Low temperatures, short reaction time, and low concentrations of hydrogen ion favor the epoxidation reaction.

Hydroxylation reactions are customarily carried out by an in-situ technique. The hydrogen peroxide is added to an aliphatic acid (formic or acetic acid) solution of the olefinic material in the presence of a mineral acid catalyst. The peracid formation and reaction with the double bond occur simultaneously. The initial intermediate is the epoxide which is opened by the aliphatic acid to yield a hydroxy ester which may be readily converted to the corresponding glycol by saponification.

$$-C{=}C- + RC(=O)OOH \rightarrow -C(O)C- + RC(=O)OH$$

$$-C(O)C- + RC(=O)OH \rightarrow -C(OH)C(OCR=O)- \qquad -C(OCR=O)C(OH)- + H_2O \rightarrow -C(OH)C(OH)- + RC(=O)OH$$

The reactions of epoxidation and hydroxylation with hydrogen peroxide and peracids are general for compounds with isolated carbon-carbon double bonds. The rate of reaction is determined by the peracid and the nature of the group attached to the carbon atoms of the double bond. Electron attracting groups such as carboxy, keto and aldehydo groups materially inhibit the reaction. Electron releasing groups, such as alkyl groups, increase the rate of reaction.

The epoxidation is acid catalyzed and with peracids probably goes through the following steps.

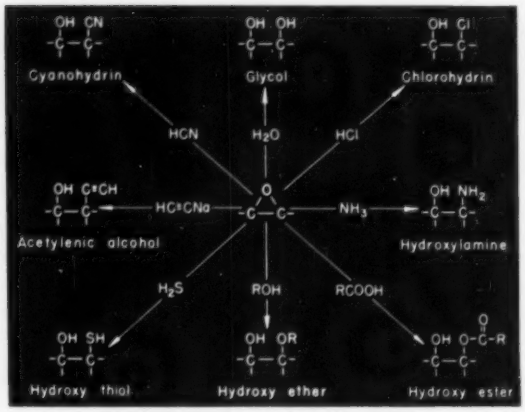


FIGURE 3—Typical reactions of epoxides.

$$RC(=O)OOH + HA \rightarrow RC(=O)OA + OH$$

$$RC(=O)OOH + CH_2{=}CHR \rightarrow CH_2(OA)CH(R)OC(=O)R \quad \text{(I)}$$

$$CH_2(OA)CH(R)OC(=O)R \rightarrow [CH_2C(OH)CH(R)]^+ + [RC(=O)O\cdots HA]^- \quad \text{(II)}$$

$$[CH_2C(OH)CH(R)]^+ + [RC(=O)O\cdots HA]^- \rightarrow RCH(OH)CH_2OC(=O)R + HA$$

I is a *pi* type complex and II is a protonated oxirane.

Uses—The epoxy compounds and glycols resulting from these reactions have many actual and potential uses. Epoxy compounds are acid acceptors and are used as stabilizers in chlorinated resins, lubricants, refrigerants, insecticides and similar materials. Epoxy esters of unsaturated fatty acids and oils are used as plasticizers for vinyl polymers. Various epoxy compounds are used as insecticides, with Dildrin being the best known. The epoxides of fatty acids and the corresponding dihydroxy fatty acids have been proposed as lubricants and lubricant additives, specialized surface-active agents, and for the production of alkyd resins. Epichlorohydrin (CH_2OCHCH_2Cl) is a basic raw material for the production of Epon resins.

The reactions of oxidation, epoxidation, hydroxylation, ring cleavage, quinone formation and free, radical reactions offer an interesting and profitable future for hydrogen peroxide. Its production and utilization should continue its current rate of increase. Much of this new production and utilization will come from the petrochemical industry. ##

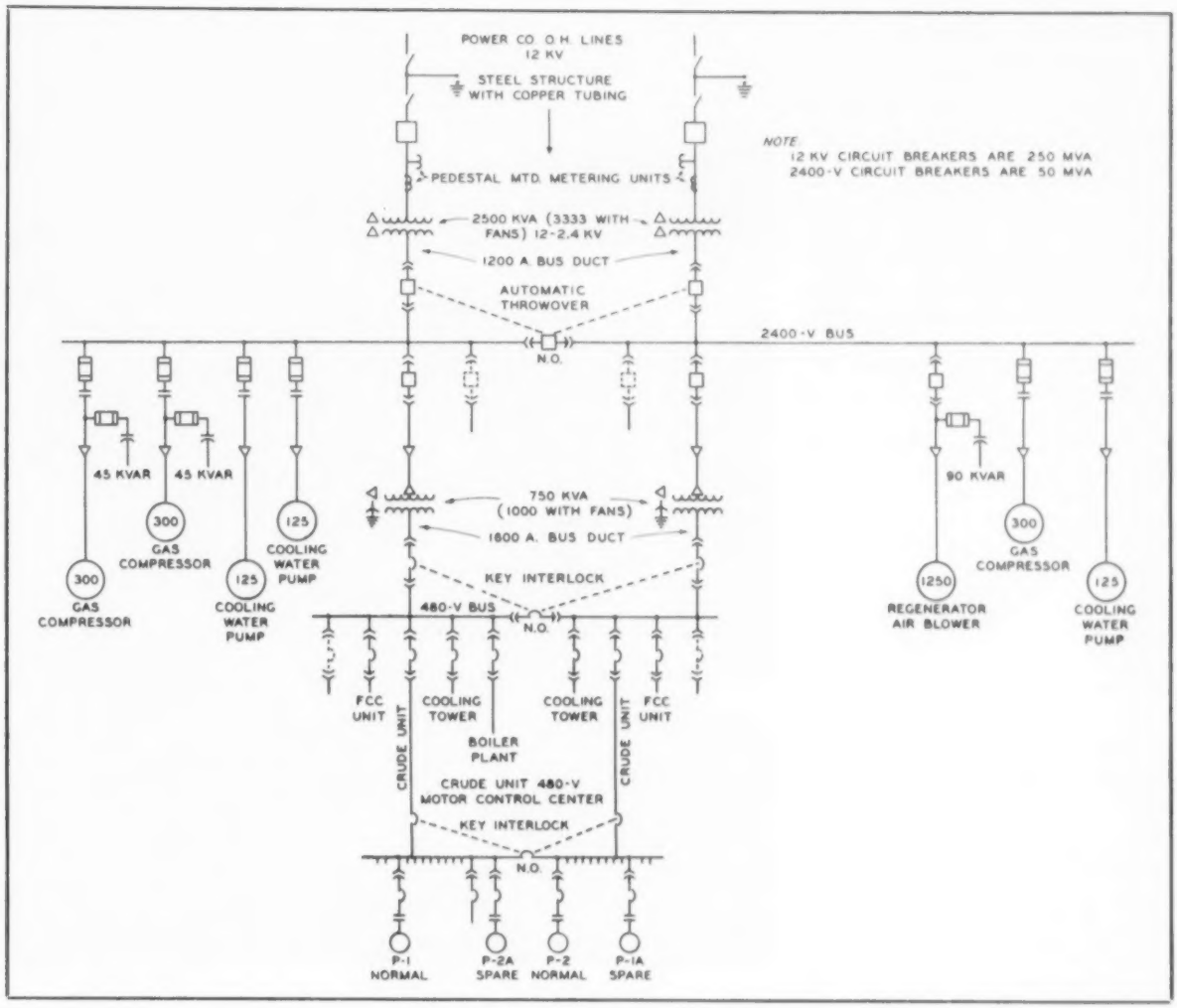


FIGURE 1—Electrical system one-line diagram.

An approach for . . .

Designing an Electric Power System

Here is the basis that was established for the Stanovan Refinery electrical distribution system design.

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AN UNUSUAL opportunity to design an entirely new electrical distribution system was provided by the recent addition to Stanovan Refinery of Standard Oil Company of British Columbia. These facilities consisted of an 11,000-barrel per day crude unit, fluid catalytic cracking unit, polymer unit, steam boiler plant, cooling tower, and associated equipment. A complete new power system was required.

As a part of the basic study for the refinery addition, an analysis was made of the relative economy of steam and electric drives for the major loads. All steam drives not fitting into the heating steam balance would have required additional steam generating capacity. Electric power, however, is available in Vancouver at a relatively low rate, and the study showed that electric motor drivers would be the correct choice for practically all refinery loads. As a result of this study the following basis was established for de-

sign of the system and selection of major equipment:

- Provide a reliable power system with two sources of supply, double-transformer capacity, and dual feeders.
- Install motor driver without spare for the 1250-hp generator air blower in the fluid catalytic cracking unit.
- Install three motor-driven gas compressors, each with 50 percent of the required capacity.
- Install three motor-driven cooling tower pumps, each with 50 percent of required capacity.
- Use motor drivers with motor-driven spares for all other process pumps except provide turbine-driven spares in cases where pump failure would cause danger to personnel or damage to equipment.
- Install steam generation and distribution facilities of limited capacity commensurate with process requirements.

Power Supply—In order to provide maximum reliability of service, the utility installed two 12-kv circuits from a main substation about three miles away. The circuits are fed from separate 12-kv buses in the substation and run to the refinery over separate routes. One of these circuits also supplies an adjacent refinery. Although usual practice in this area is not to provide lightning protection on such circuits, the utility installed lightning arresters as additional insurance against power interruptions.

Distribution System—Having established a reliable power supply, the next requirement was to select a system that would provide the maximum possible service continuity to all the loads consistent with economical design. An outage of only a few minutes would be costly, especially if the 1250-hp regenerator air blower in the fluid catalytic cracking unit was involved.

Secondary-Selective System—Several alternative switchgear arrangements were investigated. A secondary-selective system as shown in Figure 1 with the load normally divided between the two sources of supply was selected. A spot network system with two sources in parallel and reverse power relaying was considered but eliminated because of its cost and because the utility did not wish to parallel the two 12-kv circuits involved.

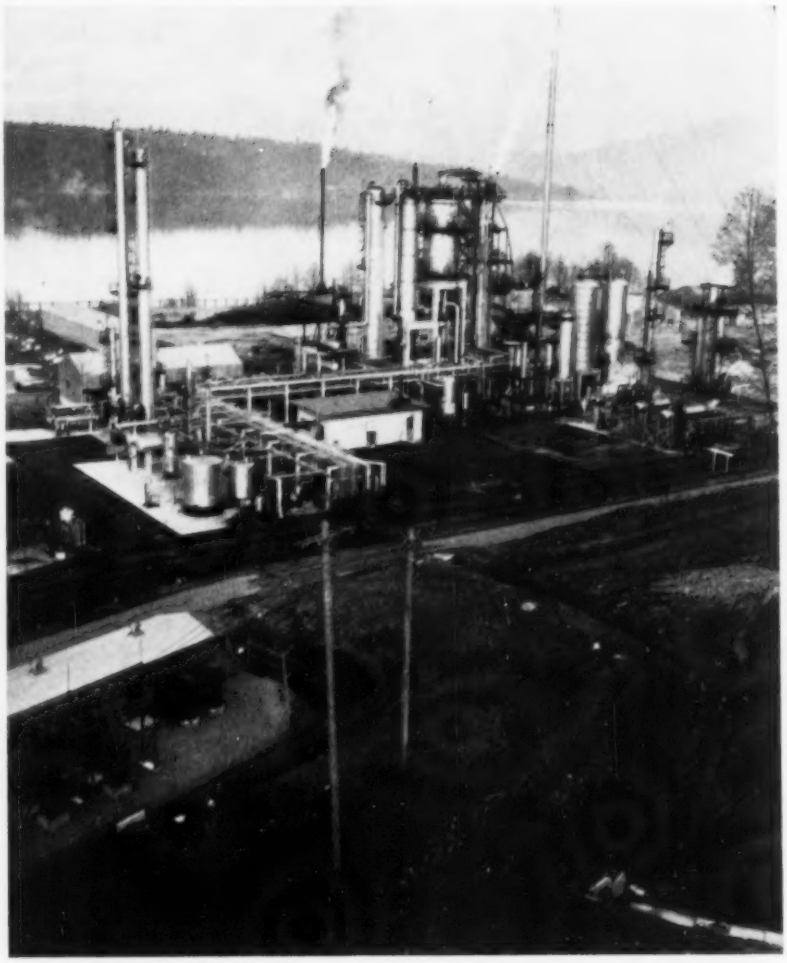


FIGURE 2—General refinery view.

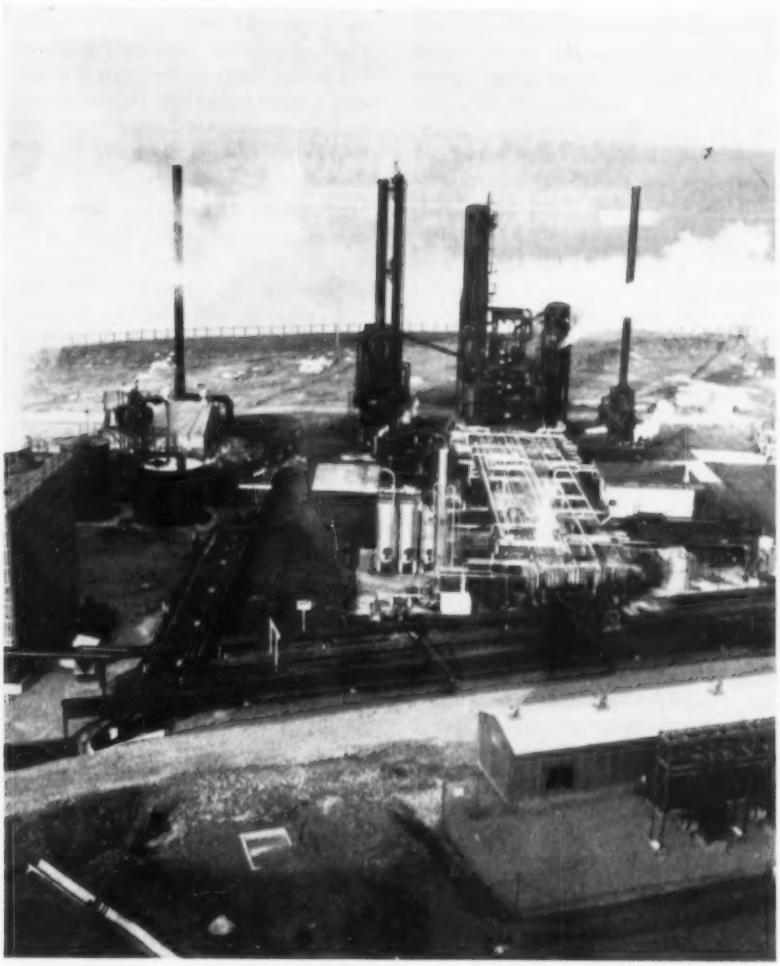
A primary selective system without double transformation to 480-v was also considered but discarded because of the premium for additional 12-kv, 250 MVA circuit breakers. A cost analysis showed that 2400-v was more economical than 4160-v for the secondary voltage on this relatively compact plant. An expanded system with twice the initial load was used in the analysis.

The concept of maximum reliability consistent with economical design was carried through the remainder of the system. The transformers are sized so that one of each pair of transformers at the two voltage levels can carry the entire load. The 2400-v bus-tie and main circuit breakers are arranged for automatic transfer on failure of either power source.

With the exception of the circuit-breaker starter for the 1250-hp motor on the regenerator air blower, any 12-kv or 2400-v circuit breaker can be removed for maintenance during plant operation. The bus-tie circuit breaker in the 480-v switchgear is key interlocked to the main breaker on each half of the bus.

Delta and Grounded Systems—The 480-v system is solidly grounded because faults are immediately isolated and easily located. Also, overvoltages on other circuits are prevented.

The 2400-v system is delta-connected. Continued operation of the 2300-v motors until time for convenient shutdown was considered more important than the prevention of overvoltages resulting when one phase is grounded. Arcing grounds with transient over-voltages are not likely with all circuits in conduit. Location of a ground is not difficult with the split bus and with all of the 2300-v motor starters in the substation. Ground detector lights are provided.



Substation Arrangement—As shown in Figure 2, the utility's incoming overhead circuits terminate at a steel structure. Pole mounted gang switches are installed on the first pole inside the refinery property. Substation 12-kv equipment includes disconnect switches, lightning arresters, 250-MVA circuit breakers, and pedestal mounted metering units. Copper tubing is used from the structure to the transformer primary bushings. Transformer secondaries are bus-connected through the substation building wall to the 2400-v switchgear mounted indoors.

The switchgear utilizes 50-MVA drawout type oil circuit breakers. An across-the-line circuit-breaker starter is used for the 1250-hp motor. Motor starters of the current-limiting-fuse type are installed for the other 2300-v motors at the end of each switchgear bus. Capacitors connected in parallel with the larger motors are installed in the bus transition compartments.

Underground cables run from the 2400-v switchgear to the primaries of the transformers to 480-v. These transformers are mounted outdoors in line with the transformers to 2400-v. Secondaries are bus-connected through the substation building wall to the 480-v switchgear. Station batteries are installed in a separate outside-ventilated room at the end of the building. Motor control for the cooling tower fans is also located in the substation.

The substation building is a prefabricated 20-foot x 80-foot corrugated aluminum building with an insulated roof. Steam unit heaters maintain a minimum temperature of 50 F. This design resulted in a significant saving compared to outdoor switchgear. In addition, the design permits easier operation and maintenance.

Automatic Transfer—If a failure should occur on either source of supply, the main 2400-v circuit breaker on this source opens and the bus-tie circuit breaker closes, thereby transferring the entire refinery load to the remaining source. The transfer scheme incorporates the following features:

- Transfer is initiated by instantaneous undervoltage relays set at 50 percent of normal operating voltage. A 12-cycle delay is included before operation of the circuit breakers in order to prevent transfer due to a momentary voltage dip or internal fault.
- Closing of the bus-tie circuit breaker is initiated by auxiliary contacts on the main circuit breaker. Dead time is less than 20 cycles.
- Interlocks prevent throwover if both sources should fail.
- Restoration to normal service with momentary paralleling is initiated (after clearance with the utility) with a single manual switch. Restoration can also be accomplished with a 20 cycle dead time.
- Transfer either with or without momentary paralleling can also be initiated with a single manual switch.

2300-v Motor Control—All starters for 2300-v motors are located in the substation as described above.

440-v Motor Control Centers—All 440-v motor controllers except isolated starters are located indoors in plug-in circuit-breaker-type control centers. The crude unit motor control center is located in the control house for this plant. It has a split bus and a normally-open, key-interlocked tie circuit breaker. Each bus section has a full capacity feeder from the substation. Normal and spare drivers are divided between the two bus sections.

The fluid catalytic cracking unit and polymer plant motor control center is arranged in the same manner except that it has a third bus section that is automatically energized from a turbine generator if a complete power failure should occur.

The cooling tower motor control center is provided with two feeders and a split bus, but no tie circuit breaker. This unit has reversing starters for four 25-hp fan motors to provide de-icing of cooling tower air intake louvers.

The boiler plant can operate during electric power failure. Consequently, a single feeder is provided to its motor control center.

Designing An Electric Power System . . .

Automatic Motor Restarting—One of the most interesting features of the design are provisions incorporated for automatically restarting affected motors following transfer to a single power source. The designs provide for restarting automatically all 2300-v and 440-v process motors following a power outage on any bus section that does not exceed one second. The circuit-breaker starter for the 1250-hp regenerator air blower remains closed during such a momentary outage, so that this motor will pick up immediately on transfer with a minimum effect on plant operation.

The 2300-v fused motor starters on the gas compressors and cooling tower circulating pumps reclose immediately following an outage. Restarting of the 440-v motors is delayed until ten seconds after power is restored in order to prevent excessive voltage drop.

Provision for automatic restarting requires that only motors in operation before the momentary outage start on restoration of power. Drivers on spare equipment must not start. To provide this feature, conventional three-wire control circuits are used for the 440-v motors except that "on-off" selector switches are used in place of "stop" pushbuttons. A relay contact in parallel with each "start" pushbutton closes 10 seconds after power is restored. Consequently, only those motors with the selector switch in the "on" position start following an outage of 1 second or less.

Some difficulty was encountered in the 480-v motor restarting circuits during initial tests because the power outage during throwover is so short that the relays did not drop out. This difficulty has been corrected by installation of resistors in series with the relays.

Calculations indicated that the bus voltage would drop to a minimum of 82 percent following the throwover. The actual voltage drop has not been recorded; however, it is apparently close to the calculated value.

Selection of Motor Type—A forced-ventilated induction motor is used for the 1250-hp regenerator air blower rather than a synchronous motor, because of greater reliability, simpler control, and easier restarting. Totally enclosed, fan-cooled motors with gear reducers and hydraulic couplings are used for the reciprocating gas compressors. Low-speed direct-drive, forced-ventilated induction motors have been selected for the compressors being installed on a later expansion program because problems with hydraulic couplings and torque-reversal in the gears are eliminated.

Wiring System—All 480-v and 110-v circuits use single conductor heavy-wall thermoplastic insulated copper wire. The insulation is rated 600-v, oil-resistant, suitable for 80 C in air and 60 C in oil, conforming to ASTM Spec. D734-50-T. All 2400-v circuits are single conductor 5000-v, varnished cambric-and-lead with a $\frac{5}{64}$th-in. thermoplastic jacket.

The wiring system is underground in non-metallic conduit encased in concrete envelopes and overhead in steel conduit. Underground pull boxes are used. The conduits enter the pull boxes on faces sloping 45 degrees from the vertical. Deep manholes are not required. The conduits are not drained. No wire or cable failures have occurred during the first eight months of operation.

Electrical Classification—Process areas (except in the vicinity of furnaces and other ignition sources) are considered as Class I, Division 2 areas under the Canadian Electrical Code. The Division 2 areas extend a minimum of 25 feet from sources of flammable vapors, in accordance with Company practice. Control houses located in classified process areas are "pressurized" with air taken from a stack above the control house. Two fans (normal and spare) are provided, each with capacity for 15 air changes per hour in the control house. Control house interiors are considered non-hazardous. Alarms are provided to indicate failure of control house ventilation.

Emergency Generator—Since the power system has a high degree of reliability, an emergency generator is installed only to serve the fluid catalytic cracking unit and the polymer plant. The generator is a turbine-driven, 480-v, 3-phase 25-kw unit. It starts automatically and provides emergency lighting, power for instrumentation, and power for control house ventilation.

Provision for Expansion—As shown on Figure 1, two 2500-kva transformers to 2400-v were installed. These transformers have a provision for the addition of fans which would increase their capacity to 3333 kva. The present average load is about 2300-kva. Therefore, the average load could be increased by about 1000-kva and the entire load could still be carried from one source of supply. Since some loads could be transferred to turbines, the average load could be increased as much as 1500 kva without any serious sacrifice in operating characteristics.

The current expansion program which includes a platformer and crude unit modifications, will add an average load of 800-kva including four new 2300-v motors. Space is still available for one additional 2300-v motor starter without modifying the building. The cubicles for two future 2300-v feeder circuit breakers are still available. Space is available for additional 480-v switchgear.

Conclusions—Major electric drives with purchased power are practical and economical for a petroleum refinery if reliable power can be obtained and energy rates are reasonably low. The required reliability and flexibility is provided by secondary-selective systems with the load normally divided between two sources of supply and automatic transfer on failure of one source. Similar power systems are being planned for refineries in other locations. This paper was presented at the AIEE Petroleum Technical Conference, Houston, September, 1955.

ACKNOWLEDGMENT

The assistance of R. P. Howell and W. H. Levers in preparation of this paper is gratefully acknowledged.

Meet the Author

N. A. AUSTIN, an electrical engineer with Standard Oil Company of California, is assigned to design and project engineering on the power system at the company's San Francisco refinery. His duties also involve design engineering for process unit electrical design and instrumentation. Before joining the Standard company, Austin was with General Electric Company in its Test Program. There he was engaged in transformer and traction-motor design.

Depolymerize Butene Trimers

High yields of dimers and monomers may be achieved from depolymerization with a phosphoric acid catalyst.

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FOR USE in the production of aviation gasoline, butene trimers are generally less valuable than the dimers and monomers, particularly isobutylene (2-methylpropene). Methylpropene also is useful in the production of high molecular weight polymers such as polyisobutylene, butyl rubber, etc. Accordingly, trimers of methylpropene, trimers of 1-butene and 2-butene, and trimers of mixtures of these olefins were depolymerized to produce high yields of methylpropene monomer and octenes.

The Trimers used as starting materials were fractions (boiling from 170 to 178 C) of polymers of methylpropene (i-C_4H_8),1- and 2-butenes (n-C_4H_8), and mixtures of methylpropene, 1- and 2-butenes (i + n-C_4H_8). Such trimers are formed as unavoidable higher boiling products in catalytic polymerization.

In this work, the trimers were produced in the presence of UOP Solid Phosphoric Acid polymerization catalyst by the method described by V. N. Ipatieff and R. E. Schaad.[1] The properties of these charge stocks are shown in Table 1.

The catalyst was the UOP Solid Phosphoric Acid (SPA) polymerization catalyst which was described recently by V. N. Ipatieff, R. E. Schaad, and W. B. Shanley.[2] It was granular and of 4-6 mesh particle size (0.34 to 0.48 cm. sieve openings).

The apparatus for batch-wise depolymerization consisted of a 1-liter round bottom flask fitted with a Hempel or Vigreaux distilling column (30 x 2.5 cm.) connected to a receiver and water cooled condenser for collecting liquid hydrocarbons. The receiver and condenser for liquid products was also connected to a calcium chloride drying tube and thence to a trap cooled by solid carbon dioxide and acetone. This collected the condensible gases of methylpropene, n-butenes, and small amounts of pentenes, pentanes and higher boiling hydrocarbons.

An apparatus for continuous operation consisted of a charging pump for butene trimers, a steel catalyst tube surrounded by a thermostatically controlled electric furnace, a cooler and receiver for liquid products, and a trap cooled by solid carbon dioxide and acetone for collecting condensible gases including methylpropene.

The Methylpropene Trimer was depolymerized by charging the flask with 76 grams of catalyst and 500 ml. of trimer. After 5 hours, 500 ml. more trimer was added. At the end of 15 hours of heating, 600 ml. more trimer was added. The heating was controlled so that the vapor temperature at the top of the column was always 105 to 120 C. At the end of 26.5 hours total heating time, only 124 ml. of heavy oil remained in the flask with the catalyst, the remainder having passed over as gaseous and liquid products.

TABLE 1
Trimer Charge Stocks

PROPERTY	TRIMER OF		
	i-C_4H_8	n-C_4H_8	i + n-C_4H_8
B. P., °C @ 746 mm.	173-6	173-8	170-6
d_4^{20}	0.7667	0.7877	0.7660
n_D^{20}	1.4325	1.4375	1.4336
Mol. Wt.			
Found	176	168	
Calcd. for $C_{12}H_{24}$	168	168	168
Bromine Number			
Found	76	107	104
Calcd.	95	95	95
Analysis			
% C, found	85.40	85.63	
% H, found	14.29	14.23	
% C, calcd.	85.62	85.62	85.62
% H, calcd.	14.38	14.38	14.38

The overhead product was fractionated into hydrocarbons of C_4, C_8, and C_{12} boiling ranges. The C_4 fraction was analyzed by Podbielniak and Göckel gas analyses. The distribution and analyses of the products are given in Table 2.

If the depolymerization of this trimer fraction had been complete to C_4 and C_8 hydrocarbons, the octene yield (theoretical) would have been 66.6 per cent by weight or 70.5 per cent by volume of the charge, a yield about 10 per cent by volume higher than that observed in the experiments.

For two experiments, the rates of octene production were similar, namely 0.96 and 0.89 ml. per hour per gram of catalyst during the first four hours on test. Hydrogenation of the octene fraction in the presence of 10

Meet the Author

R. E. SCHAAD, with Universal Oil Products Company since 1926, now is technical advisor to the general manager of the Research and Development laboratories. Dr. Schaad started with the company as a research chemist and later served as patent agent. He is a graduate of Denison University and holds master's and doctor's degree from Ohio State University. He is a registered patent agent and a professional engineer in Illinois. He is author of a number of technical articles and holds patents in polymerization, alkylation and hydrocarbon decomposition reactions.

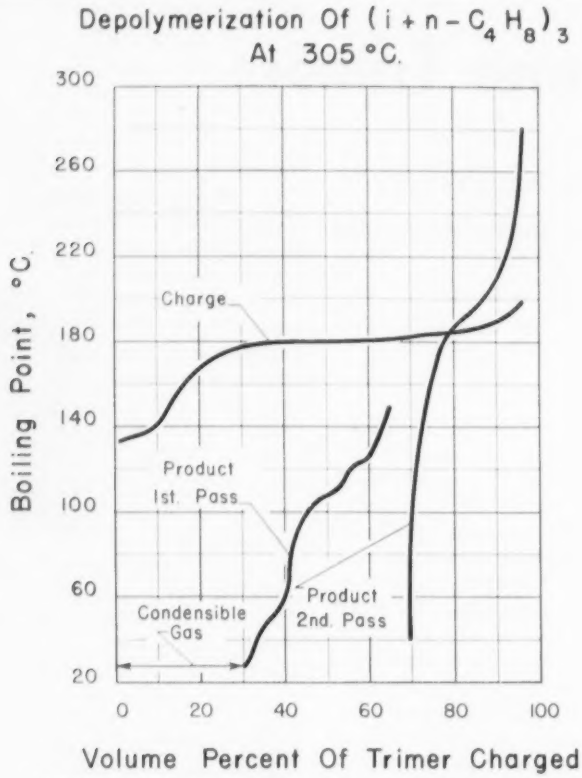

FIGURE 1—After depolymerizing a trimer of mixed methylpropene and n-butene, the product boiling above 150 C was given a second pass through the catalyst.

per cent by weight of nickel oxide at 270 C. produced an octane fraction of 92 octane number (CFR motor method).

Other Trimers were depolymerized at their boiling point, but the rates of depolymerization were slower than that of the trimer of methylpropene. The relative rates of formation of octenes from these trimers in the presence of 20 per cent by weight of the catalyst are given in Table 3. The rates are reported as milliliters of octenes per hour per gram of catalyst.

The product distribution during the depolymerization of these other trimers is given in Table 4. The C_4 fraction formed from the n-butene trimer had the highest content of butanes (mainly iso-) indicating a greater hydrogen transfer during that depolymerization.

The necessity of the catalyst for depolymerization was shown by a blank experiment in which the trimer of methylpropene (250 ml.) was refluxed for 9 hours without catalyst. At the end of this time, the overhead product and residual liquid contained only 1 ml. of liquid boiling below the trimer and having a refractive index approximately that of octenes. Therefore, the depolymerization of this trimer during 9 hours in the absence of a catalyst was 0.4 per cent.

Continuous flow of trimers from mixed butenes, and, in other experiments, trimers and tetramers of propene through a steel tube containing catalyst at 290-300 C and atmospheric pressure, charging 0.2-0.5 ml. polymer per hour per ml. of catalyst gave a yield of 20 to 45% by volume of lower boiling normally liquid hydrocarbons and also condensible gases rich in methylpropene and n-butenes equivalent to 12-35% of the volume of the polymers charged.

The depolymerization of a trimer of methylpropene and n-butane at 305 C is shown in Figure 1. The distillation curves are shown for: (1) the charge to the catalyst tube, (2) the IBP-150 C fraction of the product, and (3) the product obtained by again passing over the catalyst the residue of the first product boiling above 150 C.

Original presentation of this information was before the Fourteenth International Congress of Pure and Applied Chemistry at the July, 1955, meeting, Zurich, Switzerland.

LITERATURE CITED
[1] Ipatieff, V. N. and R. E. Schaad, *Ind. Eng Chem.*, 30, 598 (1938).
[2] Ipatieff, V. N., R. E. Schaad, and W. B. Shanley, *The Science of Petroleum*, Oxford University Press, 1953, Vol 5, Part 2.

TABLE 2
Depolymerization of Trimers of Methylpropene

Reactants
Trimers, 1600 ml. (1213.5 grams)
Catalyst, 4-6 mesh, 76 grams

PRODUCTS	Volume (ML)	Volume (%)	Weight (gms)	Weight (%)
IBP—120 C	992	62.0	707.6	58.4
120-160 C	102	6.4	72.0	5.8
Above 160 C	70	4.4	57.7	4.8
Residual oil	124	7.7	94.4	7.8
Condensible gas	379	23.7	227.4	18.7
Total Recovery	1667	104.2	1159.1	95.5
Loss	....	....	54.4	4.5

Refractive Index	n_D^{20}
Charge Stock	1.4325
Products	
IBP—100 C	1.3986
100-120 C	1.4158
120-160 C	1.4240
Above 160 C	1.4320
Residual oil	1.4650

Condensible Gas	**Percent**
i-C_4H_8	70-79
n-C_4H_8	6-11
C_4H_{10}	6-11
C_5+	8-9

TABLE 3
Relative Rates of Depolymerization

Trimer Depolymerized	C_8H_{16} Production (ml./hr./g.)	Relative Rate
n-Butene	0.06	1.0
n-Butene & Methylpropene	0.15	2.5
Methylpropene	0.65	11.0

TABLE 4
Depolymerization of Trimers of Butenes

Reactants	TRIMER OF n-C_4H_8	TRIMER OF i + N-C_4H_8
Trimer Charge		
Volume, ml	50.0	250
Weight, gm	38.3	194.8
Catalyst, 4-6 mesh, gm	7.7	39.0
Reflux time, hr	8	15
Products, gm		
IBP—100 C	1.4	24.1
100—120 C.	1.2	37.6
120—160 C	4.9	48.9
Above 160 C	0.9	
Residual oil	25.4	44.9
Condensible gas		22.0
Total recovery	35.0	177.5
Loss	3.3	17.3
Refractive Index, n_D^{20}		
IBP—100 C	1.4010	1.4065
100—120 C	1.4140	1.4152
120—160 C	1.4235	1.4439
Aabove 160 C	1.4394	
Condensible Gas %		
i-C_4H_8	45.0	66.2
n-C_4H_8	15.0	9.4
C_4H_{10}	46.0	18.2
C_5+		6.2
Total	100.0	100.0

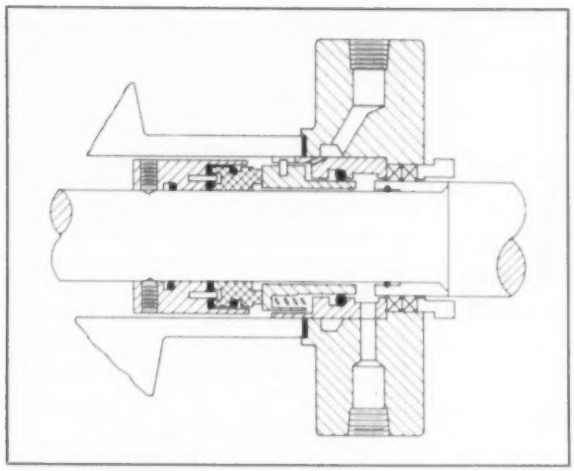

FIGURE 1—Internal seal assembly with the rotating element within the stuffing box.

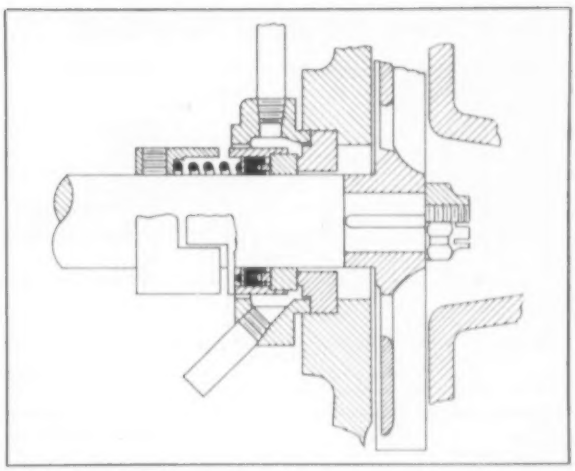

FIGURE 2—External seal assembly with rotating element outboard the stationary element.

How to Select and Install Pump Seals

Here are the basic principles essential to successful application of mechanical seals.

Ted J. Sniffen
Worthington Corporation, Houston

STUFFING BOX leakage has been a persistent problem in the applications of centrifugal pumps to process work. The first solutions were modifications to conventional packed boxes by the addition of more packing rings, cooling jackets, harder sleeves, and various lubricating devices. This trend took another direction with the application of a mechanical device to control leakage. The early seals combined conventional style packing rings with metallic elements along the basic lines of today's mechanical seals.

These devices were accepted slowly, and were first tried in the relatively easy services. A variation was the use of two seals back-to-back with clean lubricating liquid injected between them to handle the tougher jobs. This arrangement, the so-called double seal, requires the extra expense and maintenance of auxiliary seal oil equipment and introduces the risk of product contamination.

Continuing developments in seal design and materials increased confidence in single seal performance to the extent that double seals are now generally used only for extremely hazardous applications.

Mechanical seals are not the answer to all stuffing box problems, but when properly applied they can show a marked reduction in pump operating and maintenance costs. An understanding of the fundamental functions of the various seal parts is essential to successful application.

Basic Seal Elements—The single type mechanical seal consists of a rotating element fixed to the shaft or shaft sleeve, and a stationary element which is fixed to the pump casing. Adjacent surfaces of these two elements in a plane normal to the shaft have highly polished faces with a low coefficient of friction to permit extremely close contact. The other parts of the seal provide compensation (flexibility) for wear, machining tolerences and deflections, and insure sealing at static points between parts that have no relative motion with respect to each other. Two versions of the single seal in common use are the internal type (Figure 1), which is mounted within the stuffing box, and the external type (Figure 2), which is mounted at the outer portion of the box.

There are three primary sealing points (Figure 3) in mechanical seals: (1) between the stationary element and the casing; (2) between the rotating element and the shaft or shaft sleeve; and (3) between the adjacent surfaces of the rotating and stationary elements.

Conventional gaskets, or synthetic rubber "O" rings are generally employed to stop leakage between the stationary element and the casing. Synthetic rubber "O" rings or bellows and fluorocarbon wedges or cups are most commonly used to stop leakage between the rotating element and the shaft or shaft sleeve. (Leakage between the shaft and the sleeve must be stopped if the seal is mounted on a sleeve.)

Leakage between the adjacent faces is controlled to insignificant amounts by the very close contact possible between these faces. Contrary to popular conception, mechanical seal faces do not stop leakage since it would be impossible to do so and still obtain a pressure breakdown across the seal faces. In actual operation a negligible flow will produce the desired breakdown across the faces and will simultaneously maintain a thin film of

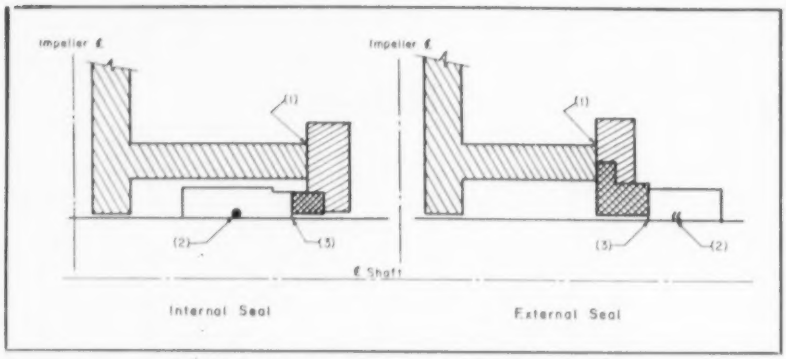

FIGURE 3—The three sealing points in mechanical seals.

liquid between the faces. This thin film of liquid acts in the same manner as an oil film in a bearing and keeps seal face wear within economical limits. The principal problem in sealing volatile liquids, which are generally poor lubricants, arises from the need to maintain this liquid film.

How the Seal Operates—The fundamental functions of the various seal parts will show how the seal operates, and will also give their relationship to the successful performance of the complete seal.

Flexibility . . . compensates for tolerances, wear, deflections, and to some extent erratic shaft operation. To do this the spring (or springs) must be in good shape and free to adjust. Seal movement cannot be restricted, as any members which are seated by the spring action must have freedom of motion. One of the most troublesome problems in seal application is maintaining this freedom when the liquid has particles in suspension, or has a tendency to deposit crystals or plate out on seal parts. Another source of difficulty comes from mounting the seal on a surface that is scored or out of round resulting in erratic action or binding.

Also important to flexibility is the proper amount of initial compression to provide sufficient seating force for the parts that are guided by the springs. Initial compression is obtained by following the seal manufacturer's axial dimensions in setting the seal. Incorrect dimensions will either result in too little initial compression, with the danger that the seal faces will pop open, or in too much compression which causes excessive wear.

The matter of correct initial compression is especially important with an external seal, since this type generally relies solely on spring pressure to keep the seal faces together as contrasted with the internal type where liquid pressure helps to seat the faces.

Sealing Against Leakage at Static Points . . . whether "O" rings, bellows, or fluorocarbon materials are used, they must be free from nicks and tears and be properly sized. Remember that these parts compensate for machining tolerances and clearances between separate pieces, and therefore must be suited to the mating part dimensionally in order to stop leaks. Also it is extremely important that the surface of the shaft or sleeve be in first class condition to insure good contact at these sealing points, and not cause binding.

The stationary element must be at right angles to the shaft, meaning that the face of the stuffing box must be square, the gland material must be sufficiently rigid to avoid distortion, and the gland bolts size and location must be adequate to securely position the gland. The gasket thickness should be carefully chosen as unequal compression on thick gaskets can cause distortions. A nominal maximum of 1/16-inch gasket is desirable.

Sealing Between the Stationary and Rotating Parts . . . this point commonly known as the "seal faces" is the focal point of mechanical seal operation. When the seal faces fail excessive leakage results, and the parts must be repaired or replaced. Initially, the seal faces are highly polished and perfectly flat.

In the course of operation, the two parts become "mated" in any irregularities of wear and therefore upon disassembly should be relapped to the original condition or replaced. Satisfactory sealing action can be maintained as long as the faces remain in intimate contact and are sufficiently smooth to sustain a thin film of liquid between them.

Seal Selection—It has been noted that the principal sealing effect is obtained by the extremely close contact of the two seal faces, separated by a thin film of liquid. This is analogous to sliding friction, and drawing from that analogy we know that the resistance to motion depends on the character of the film between the two bodies and the load that is pushing them together. Thus with mechanical seals the nature of the liquid and the pressure to be sealed determine the type of seal which is best for the job.

With the internal type of seal the pressure in the stuffing box tends to

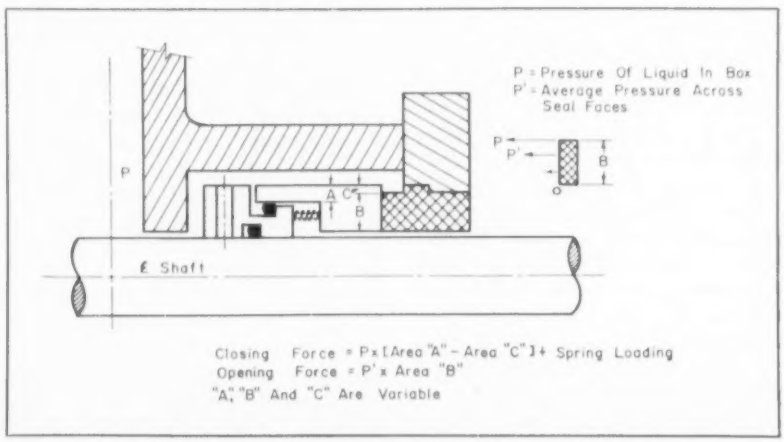

FIGURE 4—Area relationships for unbalanced seal construction.

keep the seal faces together, and this is the loading we are concerned with. The simplest design of seal is such that the entire pressure acts to close the faces. This type is satisfactory as long as the liquid handled is able to sustain a thin film between the faces under these loading conditions. In other words, as long as the liquid is a good lubricant high loads on the seal faces are not troublesome.

Such seals are known as the "unbalanced type" (Figure 4), and experience has indicated that 100 to 150 pounds per square inch gage is the maximum practical stuffing box pressure for economical service when the liquid has lubricating qualities equal to, or better than gasoline. A refinement of this basic design proportions the seal areas so that only a predetermined percentage of the stuffing box pressure becomes load on the seal faces. These seals, known as "balanced seals" (Figure 5), by controlling seal face loading make less stringent demands on the lubricating qualities of the pumped liquid. The balanced seal is the logical choice when handling volatile liquids or solvents. Balanced seals are widely available for working pressures up to 700 psig, and certain types are usable to considerably higher pressures.

An overlapping pressure range exists between 50 and 100 psig in which both balanced and unbalanced seals are usable for many applications. The choice between the two is usually dictated by costs or standardization considerations. The unbalanced design is generally most desirable below 50 psig, since this pressure represents the lower limit for best operation of most balanced seals.

The identifying characteristics of external seals is that the rotating element is outboard of the stationary element. In most cases the seal is mounted completely outside of the stuffing box, but it is possible to recess the unit within the box for some special service conditions, or when space limitations make it necessary. The position of the rotating element with respect to the stationary element means that liquid pressure acts to separate the faces, and with an unbalanced external seal the only restraining force comes from the seal spring compression. This fact limits the upper pressure limit for this type of seal to approximately 30 psig. Balanced external seals are available which are applicable up to 100-150 psig stuffing box pressure.

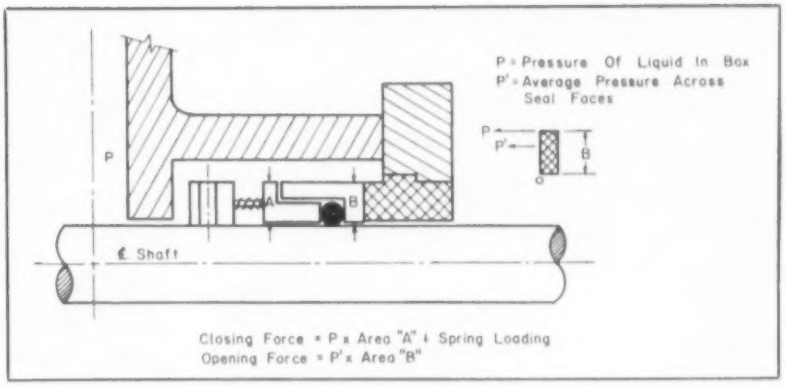

FIGURE 5—Area relationships for balanced seal construction.

The external type of seal is ideally suited to services handling corrosive or abrasive materials since the flexible members are out of the fluid being pumped. This eliminates one major source of trouble, and proper choice of seal face materials and modifications can extend the life of the wearing faces to economical limits. The modifications generally are designed to protect the faces against abrasives, and the actual arrangement used depends on the operating conditions. In these situations, field experience is the best guide to the most satisfactory type of assembly.

Installation Precautions—When handling clean liquids with good lubricating qualities at reasonable temperatures and pressures, seals can operate for several years without difficulty. Unfortunately, the most critical jobs do not offer such favorable circumstances and we must contend with dirt and grit, precipitates or crystals, volatile liquids, and with various extremes of temperature and pressure.

In regard to dirt and grit, it is needless to say that all extraneous foreign material should be eliminated to prolong the life of the pump as well as the seal. In those cases where the entrained material is an outgrowth of the process certain corrective measures can be helpful. Flushing the stuffing box with clean liquid will prevent the particles from settling out on the seal parts and impairing operation.

This flushing can be accomplished through a suitable tap on the seal gland or through the seal cage connection. In most cases it is desirable to use an external source of clean liquid from some other compatible plant stream, but a line from the pump discharge has proven effective when the primary necessity was to keep the foreign matter in circulation. It should be noted that the extremely fine particles are the most troublesome, as they are the ones that can get between the seal faces and cause rapid wear.

When the liquid has a tendency to form crystals, the flushing medium can be used to maintain the stuffing box temperature above the crystallization range. Jacketting the stuffing box is also helpful. In many cases crystals cause trouble only at the outside of the seal faces where they tend to build up in the air and the remedy is to quench this point with liquid at a suitable temperature.

Returning to the analogy between seal face action and sliding friction,

Meet the Author

TED J. SNIFFEN, with Worthington Corporation since 1949, has held a variety of positions in the company's research and development activities and in application engineering on utilities and process pumping requirements. He is now stationed in Houston, where he gives technical assistance to the company's sales force. A professional engineer in Texas, Sniffen holds a mechanical-engineering degree from Newark College of Engineering.

it is recalled that such a situation promotes local heating at the point of contact. The same thing is evident in seal operation and is a potential source of trouble when the stuffing box pressure is near the liquid vapor pressure. The addition of heat to the liquid at the seal faces can cause local flashing. The net result is that the seal is exposed to intermittent periods of handling gas with obvious impairment of the film between the faces. Consequently, seals operating under such conditions can be prone to frequent and unpredictable failure.

An effective remedy is to maintain a definite circulation of liquid around the seal to remove the heat generated at the seal faces. This is most easily accomplished by connecting a line from the pump discharge to the seal space which will induce circulation past the seal and back to pump suction. This line, often called a recirculation line and also a flushing line, is an integral feature in many pumps and especially in pumps built specifically for mechanical seals.

Conversion of pumps in the field from packing to seals can, in most cases, be done without difficulty. Of necessity sleeve or shaft surfaces that have been damaged must be renewed before the conversion can be successful. It is also important to inspect the face of the stuffing box to make certain that the gland can be made tight at this point. Many of the older pumps were not finished at the face of the box, and even the newer ones have been corroded by quenching water at this point so that refacing was necessary. It is also advisable to check the bearings and eliminate any excessive play.

Two important factors in successful seal applications are often overlooked. The first is that any inquiry which involves a mechanical seal should have complete conditions of service. This is the only way you can be assured of procuring the proper equipment, and also availing yourself of the seal vendor's best recommendations for installation. The second is that all personnel responsible for the installation and maintenance of seals should be familiar with the manufacturer's recommendations. This information is supplied with standard instructional data, and for tough services additional special instructions are usually furnished.

Seal Materials—Metallic parts for mechanical seals should be selected on the same basis as other wetted parts. That is, if the liquid being pumped dictates stainless steel, the seal parts should be of an equal or better grade of stainless; where all iron or all bronze pumps are needed the seal parts must be compatible with the pump parts. Field experience plays an important part in the evaluation of proper materials, and the user can benefit from past experience of pump and seal manufacturers by giving complete details on the liquid to be sealed.

The operating temperature and the possibility of chemical attack must be considered in the selection of synthetic materials for seal rings and gaskets. In general, synthetic rubbers are satisfactory between —30 F and +200 F in liquids compatible to synthetic rubber. The incompatible liquids can cause deterioration marked by brittleness, swelling, or complete dissolution. It is difficult to generalize on the liquids which cause these effects, but the list, Table 1, indicates general commercial practice. The temperature range for fluorocarbon extends approximately from —120 F to +450 F, and it has been proven that fluorocarbon is resistant to attack by practically all liquids pumped in industry.

TABLE 1
Suggested Synthetic Materials for Mechanical Seals
T = Fluorcarbon—R = Synthetic Rubber

Liquid	Synthetic Parts
Acetaldehyde	T
Acetic Acid	T
Acetone	T
Alcohol	R
Amine	R
Ammonia, Anhydrous	R
Ammonia, Aqua	R
Ammonium, Hydroxide <150 F	R
Aromatic Fuels <25%	R
Aromatic Fuels	T
Benzene	T
Boiler Feed Water <200 F	R
Boiler Feed Water	T
Butane	R
Carbon Tetrachloride	T
Creosote	T
Diethanolamine	R
Diethylene Glycol	R
Doctor Solution	R
Dowtherm	T
Ethane	R
Ethylene Glycol > —30 F	R
Ethylene Glycol < —30 F	T
Ethylene Oxide	T
Freon > —30 F	R
Freon	T
Furfural	T
Gasoline	R
Hydrochloric Acid	T
Isobutane	R
Kerosine	R
Monoethanolamine	R
Methyl Ethyl Ketone	T
Methanol	R
Naphtha	R
Nitric Acid	T
Oakite	R
Oleum	T
Phenol	T
Phosphoric Acid	T
Propane	R
Sodium Hydroxide (to 50%, 200 F)	R
Stoddard Solvent	R
Sulfuric Acid	T
Turpentine	R

Fluorocarbon does not have the resilient characteristics inherent in synthetic rubbers, seals employing this material are modified in design to provide a positive element to spread the fluorocarbon members. This fact plus the higher cost of fluorocarbon makes seals using this material more expensive than the synthetic rubber "O" ring or bellows type of seal. The price factor becomes more important in the pressure ranges above 90 psig.

Seal face materials are vitally important to successful seal application. There are numerous combinations employed which depend on the severity of the service and the justifiable cost ranging from the inexpensive general service seals, using cast iron and carbon faces, to the specialized combinations of ceramics, plastics or high alloy stainless steels.

Hard faced stainless steel versus carbon is the combination used for the majority of process applications. Seals designed especially for corrosive conditions often used a hardened alloy insert for corrosion resistance. In strongly oxidizing conditions that would affect carbon, impregnated fluorocarbon faces can be substituted. Seal faces made of special plastics or ceramics are available for corrosive conditions detrimental to alloy metallic parts.

The guiding principle in the selection of materials is the fact that seal faces must permit intimate contact and be sufficiently smooth to sustain a film of liquid between them. Any operating condition which destroys this relationship would cause trouble and indicate the need for different methods.

The progress made to date in seal designs and materials has encouraged widespread use of mechanical seals. A fundamental understanding of seal functions will further this trend, and also assure maximum benefits from their use. ##

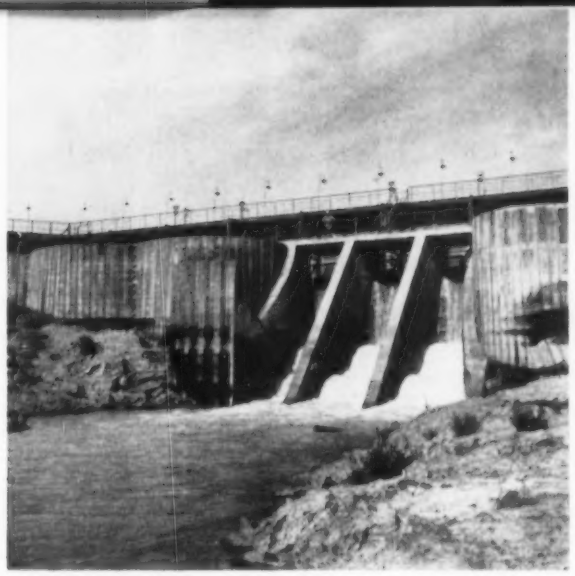

FIGURE 1—The spillway below the 30 foot overflow weir is connected on each side by circular structures.

FIGURE 2—Interlocking pile construction is used in the dam. The oil retention wall is on the left.

New approach to waste disposal gives a . . .

Low Cost Water Effluent Separator

Here's how one refinery beat high cost of a secondary effluent separator. Cost was one-fourth that of typical concrete separator.

G. F. Ullrich and J. E. Miller
Esso Standard Oil Company, Baton Rouge, La.

THE INSTALLATION of a low cost large capacity separator, in conjunction with a floating dredge and existing silt washing facilities, has enabled Esso Standard's Baton Rouge refinery to maintain a refinery effluent of consistently low oil content.

Previously, undesirable oil entrainment existed in the main refinery effluent during certain critical periods of the year. These periods came about after oily silt, resulting from the use of Mississippi River water in refinery operations, deposited in the canal downstream of the separators during periods of high river stage. As the level of the river dropped (as much as 20 feet in two weeks), high velocities in the canal caused emulsification of oil, water and solids in the effluent to be discharged to the river.

Prior to 1953 floating booms in the canal were used to recover as much as possible of the oil getting into this canal. This system did not do an effective job of maintaining low oil content effluent.

During World War II a concrete separator had been designed to clean up the final effluent but was not installed because priorities could not be obtained for the critical materials needed. Later another estimate was made and the estimated cost was over $2 million. This was excessive and it appeared that a final cleanup separator could not be justified.

Then a sheet steel tubular dam across the canal which carries the refinery effluent to the river was proposed as an alternate. The cost of this type separator appeared reasonable and in 1952 the dam and earthen separator shown in Figures 1 and 2 were designed and built. The total cost of the completed separator, including a dredge, was about $500,000.

The dam consists of a concrete spillway and overflow weir about 30 feet wide connected on each side to two circular structures made by driving sheet piling into the loose soil. These structures were then filled with soil. A single row of interlocking sheet piling then extended on each side to the earthern levees. In all, the dam is 500 feet long and about 40 feet maximum height.

Upstream from the dam a separator was excavated 500 feet long and 300 feet wide at the bottom. Sloping sides gave a width of about 500 feet at the operating level which is at elevation 32 feet. The normal bottom is maintained at elevation 5 feet. About 30 feet upstream from the dam a ¼-inch steel wall extends across the separator from elevation 15 feet to elevation 50 feet. This wall holds back any oil coming to the surface on the separator. At normal levels the wall extends 17 feet below the surface of the water and has an opening of 10 feet for the water to flow under the bottom of the wall.

Low Cost Water Effluent Separator . . .

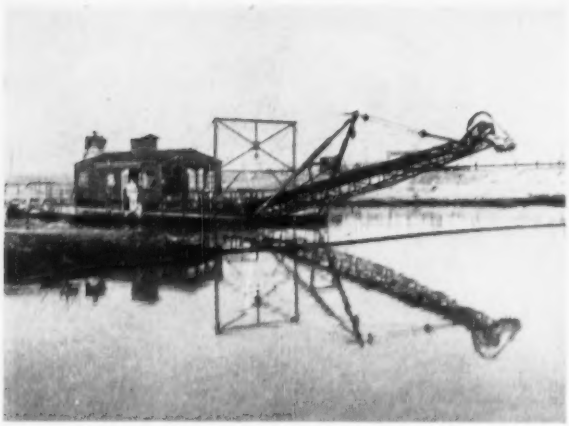

FIGURE 3—A floating dredge removes collected silt from the bottom of the separator.

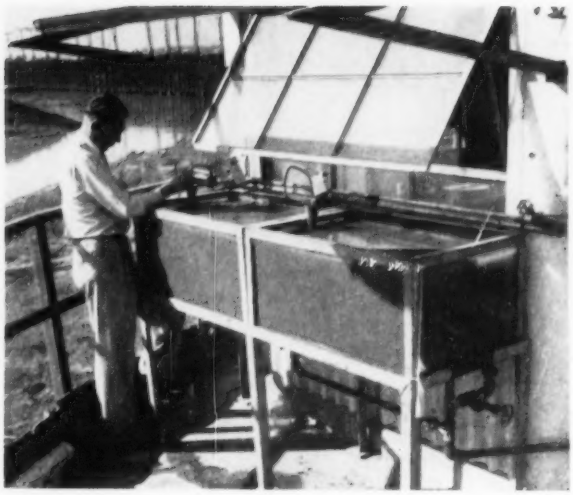

FIGURE 4—Gold fish and local small fish are kept in aquariums at the out-fall of the master separator.

Since the silt in the water would rapidly fill the separator, a floating dredge was supplied as shown in Figure 3. This dredge can pump 4500 barrels of silt and water in 1 to 2 hours, discharging the silt to one of the agitators in the company's silt washing unit. The dredge is an 8-inch suction dredge equipped with a hydraulic head for stirring up the silt enough to make it pumpable. Mixtures of 20 to 30 percent silt in water are usually obtained. The silt is washed and dumped for fill in a large pond on the batture. Silt deposition is at the rate of approximately 90,000 cubic yards per year. One charge of the 4500 barrels is made each day. This has been enough to maintain the separator at design dimensions.

The principal water supply is Mississippi river water with an average turbidity of 500 ppm. Consumption averages 100,000 to 130,000 gallons per minute and after being used for cooling purposes and in process operations this water is returned to the Mississippi river, where the average flow rate is in excess of 200,000,000 gallons per minute.

The retention time in the separator is approximately 2 to 3 hours. The material entering the master separator is about one-third discharge water from primary separators and two-thirds condenser water. The latter is river water used in barometric condensers, coolers, surface condensers and other streams relatively free of oils. However, the condenser water usually contains about the same concentration of oil as the water from the primary separators.

Ullrich

Miller

Meet the Authors

G. F. ULLRICH has been with Esso Standard Oil Company at its refinery in Baton Rouge, La., since 1938, when he completed a B.S. degree in chemistry at Loyola College of the South. Since 1944, he has been engaged in technical service and operational work in pollution control, and presently serves as assistant head of the plant's Oil Conservation division.

JARVIS E. MILLER has been with Esso Standard Oil Company since 1929. He has been connected with the company's high-pressure hydrogenation work for many years, and since 1945 has been head of the Oil Conservation division at Esso's Baton Rouge, La., refinery. He received his master's degree from the University of Texas and took his Ph.D. in chemical engineering at the University of Michigan in 1930.

An automatic sampler obtains a one-gallon sample of the master separator effluent each day. The analyses of these samples show a consistently low oil content effluent.

Most refineries have realized that certain emulsions, solids and heavy oils cannot be removed in a gravity type separator. For this reason, a determined effort has been made in the refinery to keep these materials out of the sewers. In addition, the master separator has consistently been used as a final clean-up separator and not as a primary separator. Ship ballast and other emulsion bearing streams go to the primary separators. Also, wastes likely to cause emulsification are released into the effluent at a constant rate. With these precautions the results from the separator have been very satisfactory.

Recently two 40-gallon aquariums have been installed at the out-fall of the master separator, as shown in Figure 4. River water is pumped through one aquarium and river water mixed with 10 percent of master separator effluent through the other. Gold fish and some local small fish are kept in both aquariums. Since the ratio of refinery effluent to river water at low river flow is about 1 to 200, any toxic condition due to the refinery effluent entering the river would kill the fish in the second aquarium long before it would kill fish in the river. To date, there has been no significant difference in fish mortality rate for the two aquariums.

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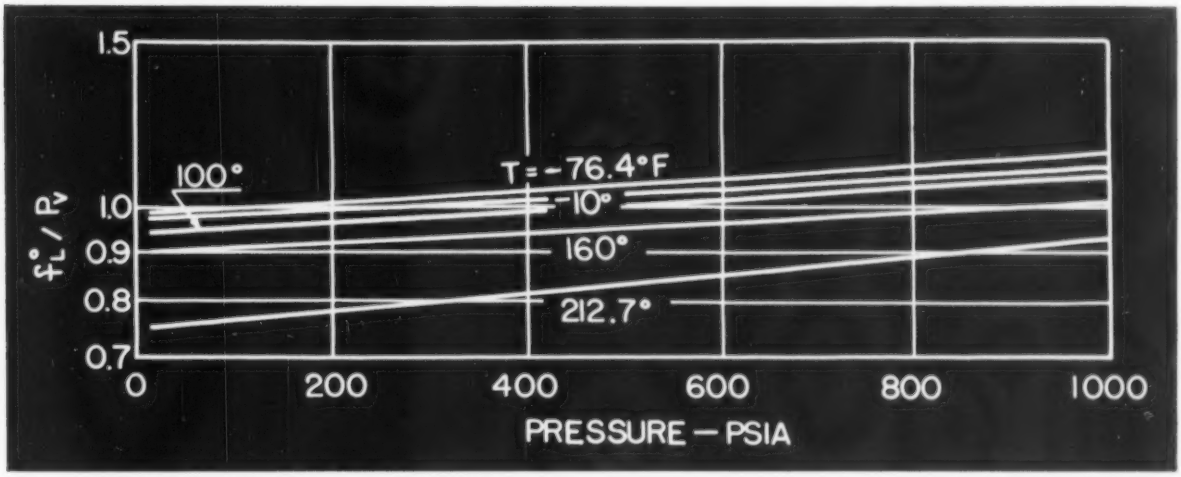

FIGURE 1—Standard state fugacity divided by vapor pressure vs. total pressure.

Need More Data on H_2S?

Vaporization equilibrium constants for H_2S are presented here over the temperature range of —76.4 to 212.7 F. and up to pressures of 1000 psia.

Dwight S. Hoffman, University of Idaho, Moscow, Idaho

James H. Weber, University of Nebraska, Lincoln, Neb.

YOU WILL find these data essential when working on absorption or stripping processes for H_2S removal. The standard state fugacity values of the liquid and vapor phases from—76.4 to 212.7 F and at pressures up to 1000 pounds per square inch absolute are presented; fugacities in the hypothetical state are shown to be consistent with those in the stable state. Also vaporization equilibrium constants are reported in both tabular and graphical form.

The vaporization equilibrium constant is defined as the ratio of the fugacity of the pure liquid at the temperature and pressure of the system to the fugacity of the pure vapor under the same conditions of temperature and pressure. It is often referred to as the ideal K and mathematically expressed as:

$$K = \frac{f_L^\circ}{f_v^\circ} \qquad (1)$$

The vaporization equilibrium constant is important; since through its use in conjunction with the liquid and vapor phase activity coefficients, it is possible to determine the ratio y/x, K′, the vaporization equilibrium ratio.

where: y = mole fraction of the component in the vapor phase
x = mole fraction of the component in the liquid phase

The relationship between the vaporization equilibrium constant and the equilibrium ratio is:

$$K' = K\frac{\gamma}{\varphi} \qquad (2)$$

where γ = liquid phase activity coefficient, f_L/xf_L°
φ = vapor phase activity coefficient, f_v/yf_v°
f_L = fugacity of the component in the liquid mixture
f_v = fugacity of the component in the vapor mixture

To determine the liquid and vapor fugacities of a pure material, it is necessary to have accurate volumetric data on the two phases. For the most part the required data for hydrogen sulfide have been determined by Reamer, Sage, and Lacey.[3] Some volumetric data were available prior to this investigation and were used by West in the calculation of the thermodynamic properties of hydrogen sulfide.[4]

In general, West used an equation of state, not based on experimental data, to predict the behavior of hydrogen sulfide in the superheated vapor region. In this investigation the data of Reamer, Sage, and Lacey were used whenever possible.[3]

In the calculation of the equilibrium constant, an assumption must be made regarding either the standard state liquid fugacity or vapor fugacity for all conditions except saturated ones. At any given temperature, if the pressure is greater than the vapor pressure, the pure component does not exist as a vapor.

Conversely, if the pressure is less than the vapor pressure, the pure substance does not exist as a liquid. In the former case, some assumption must be made to obtain the standard state vapor fugacity and, in the latter case, to determine the standard state liquid fugacity. Only when the total pressure is equal to the vapor pressure

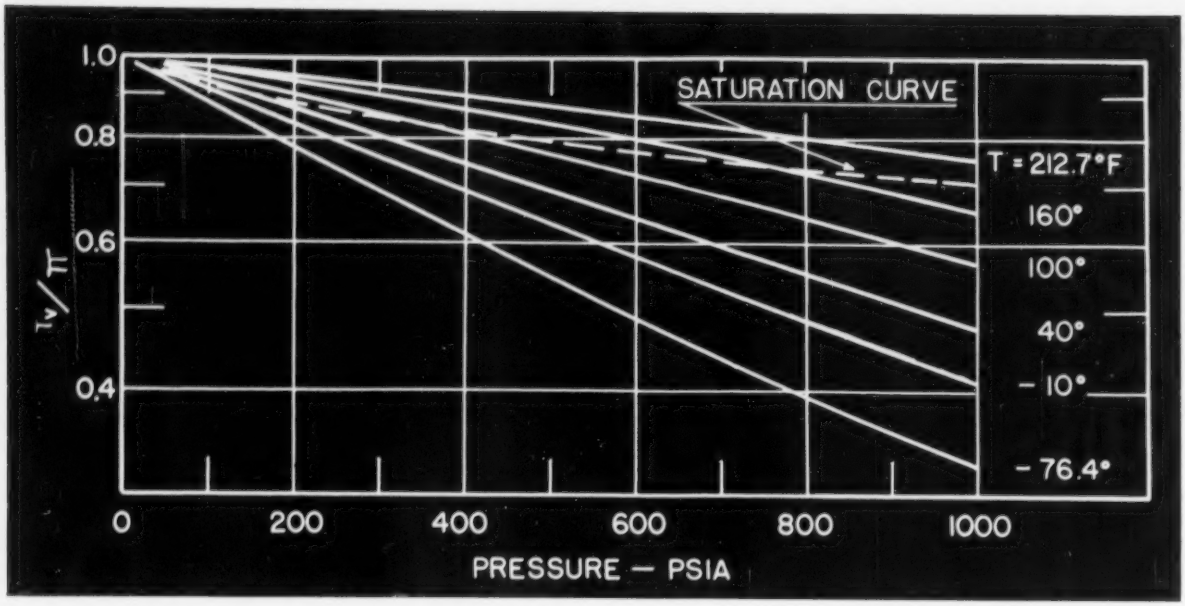

FIGURE 2—Standard state vapor fugacity divided by total pressure versus total pressure.

will the liquid and vapor phases of the pure material coexist.

Under these conditions, the two standard state fugacities are identical and the equilibrium vaporization constant is equal to one.

The standard state liquid phase fugacities presented here were calculated from the expression:

$$f_L^{\circ} = f_{PV}\, e^{\frac{V_L}{RT}[\pi - P_V]}$$

where f_{PV} = fugacity at the vapor pressure
P_V = vapor pressure, psia
R = gas law constant, 10.730 (psia) (ft³)/(lb-mole) (°R)
T = absolute temperature, °R
V_L = liquid molal volume, ft³/lb-mole
π = total pressure, psia

Since the effect of pressure on the liquid volume is small, the volume of the saturated liquid is usually substituted in equation (3) and treated as a constant. In the present work, however, the arithmetic average between the molal volume at saturated conditions and that at the elevated pressure, π, was used. This was possible because Reamer, Sage, and Lacey reported liquid volumetric data at pressures greater than the bubble point pressure.[3] This procedure cannot be used in the calculation of the liquid fugacities at pressures less than the vapor pressure. Here the effect of pressure on the liquid volume was neglected.

The standard state vapor fugacities were determined from the expression:

$$\ln f/p = -\frac{1}{RT}\int_0^{P} \alpha\, dP \qquad (4)$$

where α = residual volume, $\frac{RT}{P} - V_g$
V_g = molal volume of the gas

The right hand member of the equation was evaluated by graphical integration. At conditions of temperature and pressure under which the pure substance does not exist as a vapor, the generalized f/p chart of Hougen and Watson[2] was used to obtain the standard state fugacity.

The fugacities calculated by the methods outlined above are shown in Table 1. To show the consistency of the fugacities in the real and hypothetical states, plots of $\ln f_L^{\circ}/P_V$ vs total pressure and $\ln f_V^{\circ}/\pi$ vs total pressure were made and are included as Figures 1 and 2. The reasoning behind the selection of these two particular types of plots was shown by Hoffman and Weber[1] and applied to benzene.

As in the previous case so in the present one, when values of f_L°/P_V at a constant temperature are plotted against the total pressure, π, on semi-logarithmic coordinates a straight line results. Therefore, the f_L° values in the hypothetical state appear consistent with those in the stable state.

Meet the Author

Hoffman

Weber

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JAMES H. WEBER is an associate professor of chemical engineering at the University of Nebraska. In addition to his teaching duties, Dr. Weber carries on research in chemical engineering. A 1941 graduate of the University of Pittsburgh, he completed his M. S. there in 1947 and his Ph.D. the following year.

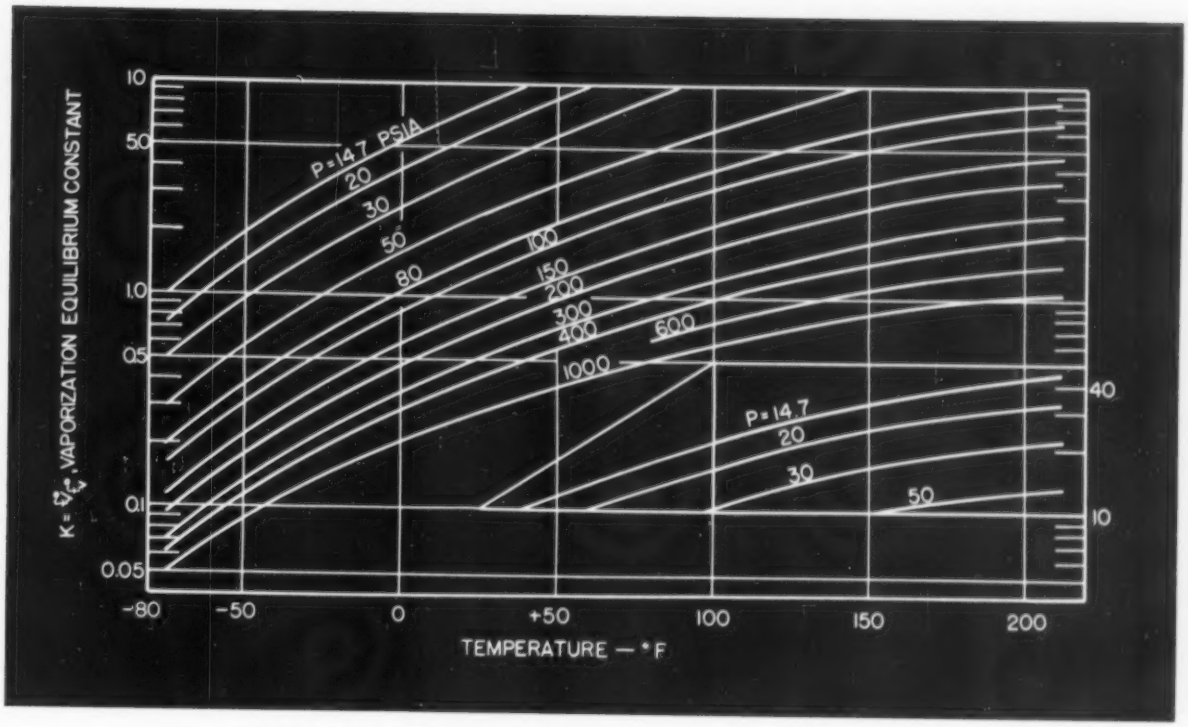

FIGURE 3—Vaporization equilibrium constant, K, for hydrogen sulfide versus temperature.

Similarly, when values of ln f_V°/π at a constant temperature are plotted against total pressure a smooth curve results. Therefore, the values of f_V° in the hypothetical state appear consistent with those in the stable state. On the two plots, ln f°/P_V vs π and ln f_V°/π vs π, a number of temperatures have been used and a series of lines obtained.

The standard state fugacities, calculated as outlined above, were used to determine the value of the vaporization equilibrium constant, K, by equation (1). These constants are shown in Table 1 and shown in graphical form in Figure 3; where they are plotted against temperature with parameters of constant pressure. Since there is no satisfactory method of evaluating f_L° at temperatures greater than the critical, vaporization equilibrium constants were not determined above 212.7 F, the critical temperature of hydrogen sulfide.

ACKNOWLEDGMENT

The authors acknowledge the help of M. Murl Maupin, Jr., with the calculations.

LITERATURE CITED

[1] Hoffman, D. S. and Weber, J. H., Petroleum Refiner, 34, No. 2, 137 (1955).

[2] Hougen, O. A. and Watson, K. M., "Chemical Process Principles," Part II, John Wiley and Sons, Inc., N. Y. (1947).

[3] Reamer, H. H., Sage, B. H., and Lacey, W. N., Ind. Eng. Chem. 42, 140 (1950).

[4] West, J. R., Chem. Eng. Prog., 44, 287 (1948).

TABLE 1—Fugacity and Vaporization Equilibrium Constants for Hydrogen Sulfide

	−76.4 F. (14.7)*			−10 F. (69.09)*			40 F. (167.58)*		
	Fugacity		Vapor Equil. Constant	Fugacity		Vapor Equil. Constant	Fugacity		Vapor Equil. Constant
	Liquid	Gas		Liquid	Gas		Liquid	Gas	
Dew Point		14.41	1.00		65.29	1.00		148.31	1.00
Bubble Point	14.41		1.00	65.29		1.00	148.31		1.00
14.7	14.41	14.41	1.00	(64.83)	14.55	4.456	(145.5	14.54	10.00
20	14.42	(19.40)	0.7432	(64.89)	19.60	3.310	(145.6)	19.71	7.386
30	14.44	(28.80)	0.5013	(64.96)	29.10	2.232	(145.8)	29.34	4.968
50	14.48	(47.50)	0.3048	(65.09)	48.0	1.356	(146.1)	48.45	3.016
60	14.51	(56.64)	0.2561	(65.22)	57.0	1.144	(146.3)	57.69	2.536
80	14.55	(74.00)	0.1966	65.42	(74.0)	0.884	(146.7)	75.75	1.936
100	14.58	(89.50)	0.1629	65.55	(91.5)	0.716	(147.1)	93.23	1.577
125	14.64	(108.1)	0.1354	65.75	(111.3)	0.591	(147.5)	114.3	1.291
150	14.68	(126.8)	0.1158	65.98	(132.8)	0.497	(148.0)	134.4	1.101
200	14.80	(157.6)	0.0943	66.40	(167.0)	0.398	148.9	(173.6)	0.858
300	15.02	(210.0)	0.0715	67.31	(228.0)	0.295	150.8	(240.0)	0.628
400	15.23	(244.0)	0.0624	68.16	(280.0)	0.243	152.6	(299.2)	0.510
500	15.46	(275.0)	0.0562	69.08	(315.0)	0.219	154.5	(347.5)	0.445
600	15.69	(294.0)	0.0534	69.99	(348.0)	0.201	156.5	(385.2)	0.406
800	16.14	(316.0)	0.0511	71.82	(384.0)	0.187	160.4	(440.0)	0.364
1000	16.61	(325.0)	0.0511	73.26	(410.0)	0.179	164.3	(480.0)	0.342

	100 F. (396.90)*			160 F. (796.74)*			212.7 F. (1306.8)*		
	Fugacity		Vapor Equil. Constant	Fugacity		Vapor Equil. Constant	Fugacity		Vapor Equil. Constant
	Liquid	Gas		Liquid	Gas		Liquid	Gas	
Dew Point		321.49	1.00		573.65	1.00		857.26	1.00
Bubble Point	321.49		1.00	573.65		1.00	857.26		1.00
14.7	(306.6)	14.59	21.02	(518.7)	14.63	35.45	(647.5)	14.64	44.25
20	(306.9)	19.83	15.49	(519.2)	19.87	26.13	(649.0)	19.89	32.63
30	(307.3)	29.56	10.39	(519.6)	29.69	17.50	(650.9)	29.74	21.87
50	(308.0)	48.79	6.313	(520.5)	49.16	10.60	(651.4)	49.34	13.20
60	(308.4)	58.27	5.292	(521.7)	58.79	8.874	(654.4)	59.06	11.08
80	(309.1)	76.94	4.018	(523.1)	77.86	6.718	(657.4)	78.33	8.393
100	(309.9)	95.24	3.254	(524.4)	96.66	5.425	(659.4)	97.39	6.776
125	(310.9)	117.6	2.643	(526.0)	119.8	4.391	(661.5)	121.0	5.486
150	(311.8)	139.4	2.237	(527.8)	142.3	3.708	(667.1)	144.2	4.627
200	(313.8)	181.2	1.731	(531.1)	186.8	2.844	(674.5)	189.7	3.555
300	(317.6)	258.9	1.231	(532.4)	270.3	1.969	(689.2)	277.1	2.489
400	321.6	(327.2)	0.983	(545.0)	347.3	1.569	(704.4)	359.8	1.958
500	325.6	(380.0)	0.857	(553.7)	417.8	1.326	(719.8)	437.8	1.644
600	329.6	(433.2)	0.761	(559.3)	481.6	1.161	(735.5)	511.4	1.438
800	337.7	(520.0)	0.649	573.9	(576.0)	0.996	(768.2)	645.3	1.190
1000	347.9	(570.0)	0.610	583.1	(658.0)	0.888	(802.1)	762.5	1.052

* Figures in parentheses are vapor pressures expressed in psia.

† Fugacity values in parentheses are those in the hypothetical states.

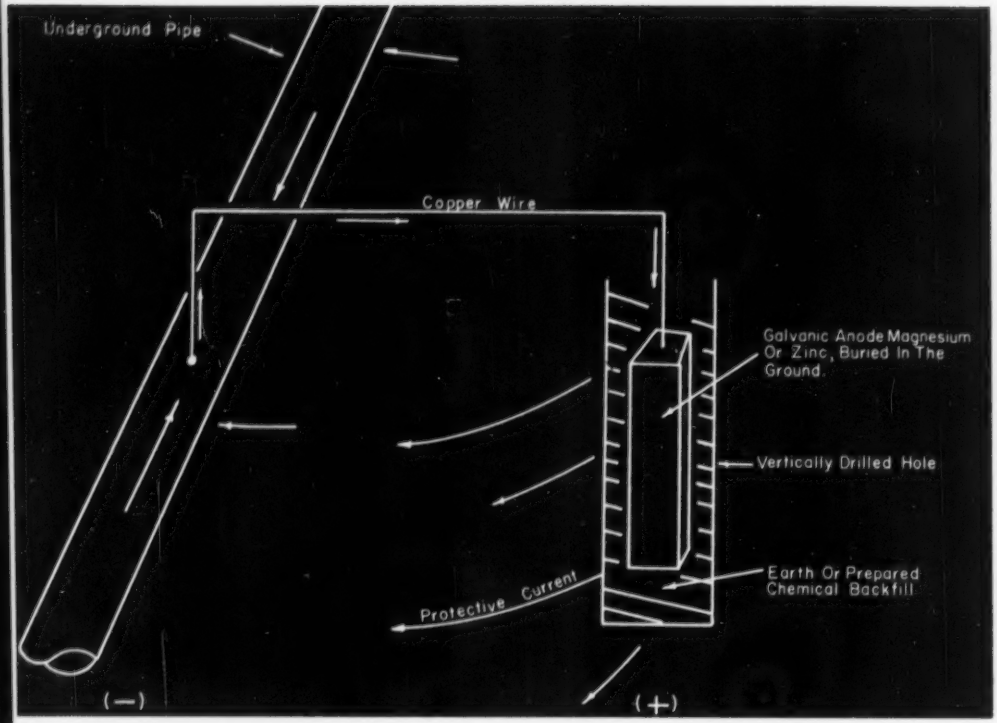

FIGURE 1—Galvanic anode type of cathodic protection.

FIGURE 2—Typical oil immersed refinery rectifier.

Save Tanks With Cathodic Protection

Here are some simple, inexpensive ways to mitigate corrosion in your tanks and underground piping.

Wayne A. Johnson
Corrosion Rectifying Company
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RECTIFYING AND GALVANIC anode systems of cathodic protection for storage plants and terminals are coming into common use. Refinement of the protective systems by the engineers with the oil and gas companies has been of great magnitude. The protection is being relied upon extensively to protect underground pipes, and tanks, and the bottoms of tanks which are resting on ground.

Electrolytic corrosion of metals in contact with soil is common, taking a $1 billion toll in the U. S. annually in replacement costs alone.[1] The application of a d-c voltage potential to metal structures prevents such corrosion by reversing the flow of the corroding currents in a direction so that the protective current flows from the soil to the metal.

Two general types of protective systems are used: the rectifying system and the galvanic anode system. Operation of the rectifying system depends on obtaining a-c voltage from an available power source and converting it to d-c so as to provide the protective current. This current is introduced into the ground through a buried grid system of "anodes," usually of a graphitic nature. The circuit is completed when the current flows thus: from the rectifier to the anode, through the ground, to the structure receiving the protection and thence back to the rectifier by a return electrical conductor cable.

The galvanic anode type of protection depends upon the use of anodes of magnesium, zinc or aluminum alloy. These anodes, when con-

Meet the Author

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nected through a copper wire to a steel structure which is also buried or is resting on the ground, will produce small amounts of protective current which flows from the anode to the metal being protected. This method is, as is the rectifier system, sacrificial in nature, the anodes being deteriorated in the process. However, they usually last for several years, depending on their original size and the comparative corrosiveness of the soil in which they are placed.

The first step in applying rectifying or anode protective systems generally starts with a preliminary study, or survey, of the facilities in question. This survey should be made by an experienced corrosion engineer, and normally will include the following:

1. General study of soil conditions to determine relative corrosiveness.
2. Calculation of total amount of metal in contact with the corrosive soils.
3. Determination of best method of applying cathodic protection (rectifying or anode):
   - (a) Availability of electric power, and cost
   - (b) Suitability of soil for each, or either, system
   - (c) Determination of possible interference with other facilities in plant
   - (d) Cost of estimate for specific period of time to determine the economy of recommended systems
   - (e) Total amount of protection to be applied

The galvanic anode system does not require an external electric power source. However, the original installation cost is often greater due to the large number of anodes required to produce a specific amount of protective current. The galvanic anodes cannot be regulated, and their operation is affected by changes in soil conditions. The rectifying systems are flexible because their outputs may be regulated and controlled. However, they require an external a-c power source and thus consume electric power in their operation.

A corrosion survey of the plant, generally accomplished at a nominal cost, will indicate the best method of protection and the cost of installing such a system. This figure should be compared with the expense of repairing corrosion leaks which may occur. The damage to a tank bottom is not, of course, all that has to be considered, although repairs or replacements often amount to several thousands of dollars for the larger capacity tanks. Loss of fluid products, damage to other facilities, downtime, fire hazards are all part of the whole picture, as is the decreased value of deteriorated facilities. After all of these considerations are taken into account and compared to the cost of the protective installation a clearer picture is obtained. It is worth mentioning that most of the larger oil companies are using protective rectifying systems in the refineries and bulk plants. Many such systems are being installed to protect underground tanks such as those used at gasoline service stations. Experience with underground corrosion, and the beneficial effect of cathodic protection, has resulted in the adoption of this method of protection because of its obvious economic advantage.

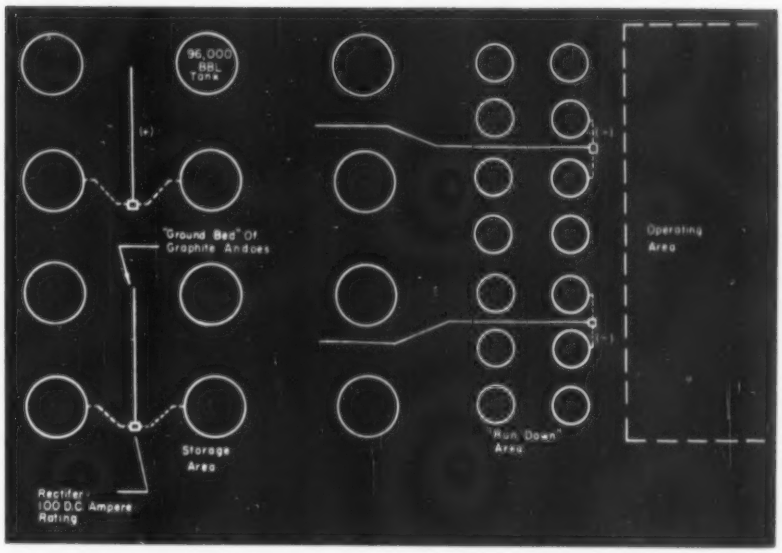

FIGURE 3—Refinery corrosion mitigation system using rectifiers.

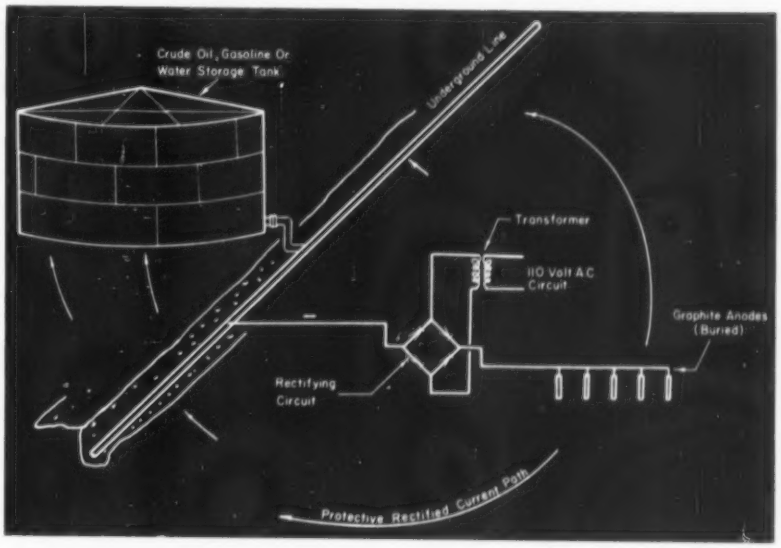

FIGURE 4—Schematic detail of rectifier installation.

LITERATURE CITED

1 *Chem. & Engr. News*, Sept. 1949.

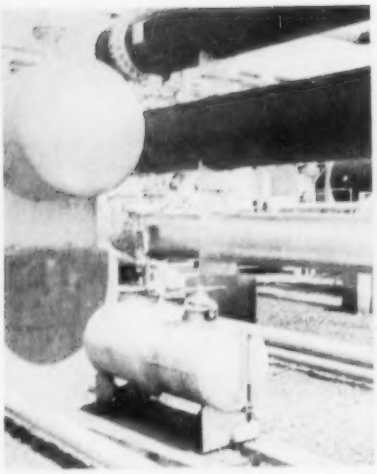

FIGURE 1—Inhibitor injection equipment for exchanger and steam stripping still.

FIGURE 2—Gravity acid and inorganic inhibitor feed arrangement at cooling tower.

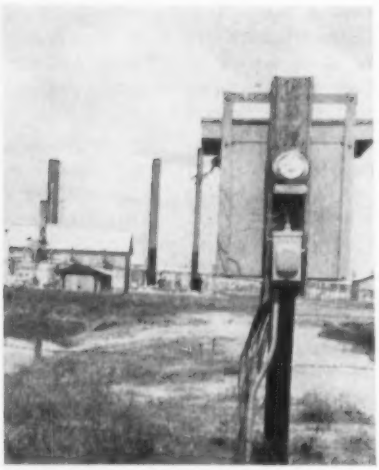

FIGURE 3—Rectifiers at edge of plant yard to protect underground piping.

Preventive maintenance by . . .

Mitigating Gasoline Plant Corrosion

There are many places in the gasoline plant that have corrosion problems which can be brought under control.

D. R. Fincher
Tide Water Associated Oil Company
Weimar, Texas

CORROSION IN gasoline plants is a problem that probably has not received the attention of corrosion engineers to the extent of other phases of the petroleum industry. Actually, there is a wider variety of corrosion problems associated with gasoline plants than almost any other hydrocarbon recovery operation. In these plants, corrosion can occur from:

- Dissimilar metals in an electrolyte
- Absorption by water of acid gases from the hydrocarbon stream
- Organic acids from producing wells
- Recirculating cooling water containing oxygen
- Carbon dioxide absorbed in condensed steam
- Soils
- Oxygen

No one vessel usually suffers from all of these corrosion mechanisms, but it is quite likely that one or more are involved in each case. The operation of a gasoline plant will be considered here along with possible corrosion problems.

To segment gasoline plants for the purpose of considering the corrosion problems of each phase, it is logical to begin with gathering lines. Their purpose is to gather either low-pressure casinghead or high-pressure gas for the plant. Corrosion experienced in these lines may be either internal or external. First, considering the internal problem, the causative agents are usually found to be either (1) acid gases such as hydrogen sulfide and carbon dioxide, or (2) organic acids. The mechanism of this corrosion involves water, either fresh or salty, that is present due to condensation in the line or carry over from lease separation facilities. Water, in the presence of acid gases, results in an acid solution which attacks the metal usually in the bottom of the line. The simplest way to detect this type of corrosion is by water analyses for iron at the lease and at the plant. By knowing the volume of water being handled, the loss of iron in #/day can be obtained.

Mitigation of gathering line internal corrosion can be accomplished by

- Use of neutralizing inorganic inhibitors
- Use of caustic volatile amine inhibitors
- Treatment of the producing wells with inhibitors where no separation is made at the lease.

The following case histories reflect some of the uses of each method of mitigation.

1. At an East Texas plant, a 6-inch and 8-inch casinghead gas line five miles in length gathers 2500 Mcf per day. This line was installed in 1949 and consisted of light weight invasion pipe. Internal corrosion failures occurred within one year after installation, and since the water involved was fresh, caustic soda has been used in this line to date. Iron contents of the water have decreased from 150 parts per million to 10 to 20 ppm while the pH is maintained at 8. No further

leaks have occurred, and the cost of treatment has been approximately $0.30/M³CF.

2. In a South Louisiana casinghead gathering system, all the lines cross canals which causes water accumulation in the bends or sags on the bottom of the canal. Iron contents of water from these lines were in the order of 500 ppm before a caustic, volatile amine inhibitor was injected. The iron content of water withdrawn from plant scrubbers has been reduced to 20 to 40 ppm at an approximate cost of $0.14/M³CF.

3. In a South Texas plant gathering system, iron content of water at the wellhead was approximately 200 ppm and had increased to approximately 250 ppm at the plant. Treatment of the wells was initiated to reduce iron content at the wells to 40 ppm and this content had increased to only 50 ppm at the plant separator. In this case, well treatment had also accomplished gathering system protection; however, this method of protecting gathering lines is not always successful.

While citing instances of success in corrosion control, certain failures should also be considered.

1. At one plant, boiler blowdown water with a pH of 12 was used as neutralizing inhibitor in the gathering system for a short time. This practice proved to be a practical method of control, but too expensive due to the labor involved in handling the necessary volume of blowdown water.

2. The coating of corroded lines with sodium silicate proved to be successful in corrosion control, but interferred with plant operations by plugging heat exchange equipment.

3. In the treatment of low pressure casinghead gas gathering lines, the use of conventional amine inhibitors has not provided corrosion control. It is believed that the low velocity usually existing in such lines does not allow the establishment of a protective film.

External corrosion of gathering lines, can be equally as severe as internal corrosion. However, a good cathodic protection program is very effective in reducing this expense.

1. In East Texas, a 24-mile product line between two plants was being severely corroded in 1948. Ten leaks occurred in 1948 each of which cost about $285 for repair plus $1000 in lost production. Cathodic protection by magnesium anodes was provided in early 1949. Since this time, one additional leak has occurred and it is no longer necessary to employ a line walker. There has been approximately $9000 expended for cathodic protection of this line to date, which is less than the expenses of walking the line.

2. Severe external corrosion was also experienced on a casinghead gas gathering line in East Texas. Cathodic protection by magnesium anodes was provided after three leaks occurred 16 months after the line was laid. No further leaks have occurred to date, and it is estimated that cathodic protection of this line paid out in 9½ months.

3. In plants built in southern Louisiana and South Texas in the last five years, all lines were coated and wrapped and cathodic protection provided when the lines were laid. No corrosion leaks in these systems have occurred to date.

In the plant proper, gas from the field is passed to the absorber where the liquefiable hydrocarbons are contacted with circulating, or absorption oil. Dry or residue gas is then sold to gas transmission companies. The rich oil is passed through a series of flash tanks to release entrained light gases. The rich oil is then fed to a still to fractionate wild natural gasoline and lean oil to be used again in the absorber. Steam is generally used in this vessel as an aid to fractionation. Depending on plant design, fractionation units may include a debutanizer, a deisobutanizer, a depropanizer, and a deethanizer.

In the plant flow system, corrosion can occur in all of these vessels and the heat exchange equipment used in conjunction with them. The causative agents are usually acid gases contributed by the hydrocarbons from the field or present with steam. Evidence of corrosion attack may be obtained by:

- Water analyses for iron
- Non-destructive testing
- Coupon exposure
- Visual inspection

Usually the most practical method is by analyses of water for iron, although these values may be misleading if the attack is concentrated in one section of the unit.

To determine if corrosion is occurring in process equipment, our practice is to obtain water samples for iron analyses and pH determination from every point where water is removed from the vessels. These analyses, along with water volumes, will allow the calculation of iron removal in #/day, which gives an arbitrary index of corrosion. Experience has indicated that the steam stripping still is the vessel most likely to be corroded.

The next step is selected of suitable inhibitors—either organic, inorganic, or both. All have certain advantages and disadvantages. Organic inhibitors are likely to cause emulsions above certain critical concentrations and the detergent action of this class of inhibitor has been known to cause plugging by loosening scale and corrosion products. Inorganic caustic inhibitors can accelerate attack on admiralty metal if the pH exceeds 8.0, and scale, and plugging, is more likely to occur with inorganic inhibitors.

After selection of inhibitors, the best point of injection must be determined. Of course, it is advantageous to treat as much of the plant at at one injection point as possible. However, it is sometimes necessary to inject chemical at two or more points in order to distribute inhibitor thruout the systems. Consideration should be given to whether or not the inhibitor will work its way up the fractionating column. If travel up the column with the lighter hydrocarbons is unlikely, then the inhibitor should be injected at the top of the column. Quite often the inhibitor may provide good protection when fed with the reflux stream.

In one plant, corrosion was experienced in the steam stripping still, absorption oil pumps and piping, and absorption oil storage tanks. This oil had very slight amounts of water entrained in it, which was believed to be a cause of corrosion. By feeding an organic inhibitor in the steam stripping still at the rate of one quart per thousand barrels of oil make, the iron content of condensed steam from this still was reduced from 56 ppm to 5 ppm, the repair of absorption oil pumps and piping was eliminated, and the storage tanks are still in service after visual inspection before treatment in 1951 indicated they would have to be replaced within one year. In using this inhibitor, however, it was found that emulsification would occur to render the oil useless when

too great a concentration was injected in the system.

In another plant, the injection of another amine inhibitor has had equal success in eliminating corrosion. This inhibitor is fed in an oil to oil heat exchanger where plugging was a problem (Figure 1). A black deposit gradually restricted the flow through the tubes until manual cleaning was necessary. Since initiating this inhibitor in the rich oil stream, the pressure drop across the tubes has been reduced by 75 percent and the iron content of the steam condensate from the stripping still has decreased by 90 percent. With no further injection points, water from the stabilizer and de-ethanizer has obtained 10 to 20 percent protection based on iron content. Since there is some risk in using inorganic caustic in the presence of admiralty metal and this inhibitor apparently does not need pH control, a more widespread use of it is planned.

In one plant where corrosion was indicated in a de-ethanizer column, a volatile amine was used with considerable success. Some 80 percent protection was indicated and LPG storage tanks received some benfit of the treatment. Inhibitor was fed to adjust the pH of water in the de-ethanizer reflux accumulator to 8.0. This inhibitor was used in preference to ammonia because it was considered less dangerous to brass and admiralty metal. The treatment has been discontinued, however, since the cost of treatment was not considered to be economically justified.

Heat transfer units are very troublesome as far as corrosion is concerned. Quite often corrosive fluids are being handled on both the shell and tube side. Penetration of the wall causes the leaking tube to be plugged, and, as corrosion progresses, the heat transfer becomes less and less efficient as more tubes in the bundle are plugged.

Indication of corrosion in heat exchangers can be accomplished by coupons to a degree, but inspection, when possible, is more reliable. In some cases, failures occur in these units when one side is being treated with inhibitor. Perhaps, the best corrosion mitigation effort is made when the tube material is selected and installed. Admiralty metal has proven to be superior to carbon steel tubes in most cases. However, corrosion of exchangers with admiralty metal tubes can occur.

Meet the Author

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In an East Texas plant, caustic boiler blowdown water has been used in the steam side of exchangers for many years. With this treatment, pH is maintained at 8.0, and the life of tube bundles has been at least doubled. With this type of treatment, one should be very certain that the total solids of such water is not high as plugging could occur due to flashing the blowdown into steam.

Cooling water and cooling towers are another corrosion problem closely related to heat exchangers. Bad cooling water conditions can cause scale and/or corrosion. Conditioning water is a field by itself, but the corrosion engineer should make certain that the best possible water source is obtained and that control limits of cooling towers are specified and maintained.

The use of pH control and inorganic inhibitors (Figure 2) has proven to be satisfactory in controlling both scale and corrosion. By the use of sulfuric acid, the pH of cooling tower water in two plants is being held slightly acidic and a chromate-phosphate mixture is added to control corrosion and scale. In one of these plants, coupon corrosion rates were reduced by 60 to 80 percent and heat exchanger repair has also been reduced. In the other plant, prior to treatment, an exchanger plugged after three months of operation and a complete plant shut down for 24 hours was necessary in order to manually drill out the scale. Treatment was begun soon after, and no further trouble of this nature has been encountered.

Failures in corrosion control of cooling water problems have been experienced from:

- Use of organic amine type inhibitors and organic scale removers
- Use of sodium silicate
- Use of bi-metal tubes

The bi-metal tube failure occurred in an East Texas plant that uses refrigeration as an aid to absorption. Ammonia is used as a refrigerant and cooling tower water cools the ammonia vapor between compressions. Since ammonia does not attack steel tubes and the cooling water does not attack admiralty metal with the severity that it attacks steel, double-walled tubes were installed with the ammonia in contact with steel and the cooling water in contact with admiralty metal. At the tube sheets, an attack occurred, due to dissimilar metals, resulting in the penetration of the steel tube which, in turn, allowed the ammonia to attack the admiralty metal tube.

In the control of corrosion of piping in and around cooling towers, the use of vinyl tapes has proved to be as successful and as easily maintained as any system used. This corrosion is attributed to atmospheric, or oxygen attack and a protective barrier is the only practical answer to the problem.

Steam generating equipment in a gasoline plant can present corrosion problems as well as caustic embrittlement problems. In these problems, the corrosion engineer receives a very definite benefit from boiler inspectors of insurance companies. Boiler problems depend so much on make-up water that treatment of boilers will not be considered within the scope of this paper.

Although the trend of newer plants is toward aboveground piping, some of the older plants have considerable piping underground. Repair of this piping is usually expensive since it is very complex in arrangement. Rectifiers to provide cathodic protection of underground piping have reduced this type of corrosion expense (Figure 3). It is estimated that these units were paid out in one year's time by reducing repair labor alone.

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ACKNOWLEDGMENT

The writer wishes to express his appreciation to fellow employes of Tide Water Associated Oil Company for assistance in preparing this paper.

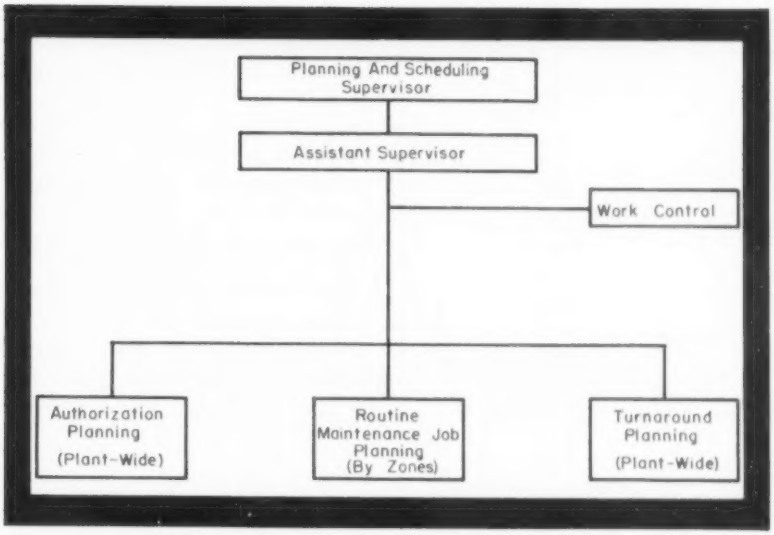

FIGURE 1—Planning and scheduling organization.

How Maintenance Costs Can Be Controlled

Atlantic Refining Company's five-year improvement program is paying off. The methods they used can be put to work by others.

E. C. Newton and M. A. Conetta
The Atlantic Refining Company, Philadelphia, Pa.

MAXIMUM UTILIZATION of refinery equipment is attained only through the concerted efforts of many groups. Included are process, research, engineering, inspection, maintenance, and all service groups. Here is an account of the contribution of one of these organizations to the joint venture.

The Mechanical (maintenance) Department's standardized craft methods and related engineered job times, together with the wholehearted co-operation of process and service groups, are proving extremely effective in work planning and manpower scheduling at the Philadelphia Refinery of The Atlantic Refining Company. These factors are materially improving manpower utilization and reducing work costs. This was particularly evident during a recent modernization program when extremely tight construction schedules, involving the co-ordination of contracted work, had to be met in order to get five large new processing units into operation at the earliest possible date. In addition, reductions in refinery unit turnaround manpower requirements have been made.

Initial Developments—In 1950 a program was begun with the ultimate purpose of setting up a system for manning jobs in the most adequate yet most economical way possible. From its inception this program progressed along several essential lines; namely, standardization of work methods for all major mechanical crafts, training of supervisors and craftsmen in these techniques, development of related engineered planning times, improvement in the planning and scheduling organization and system, and packaging of larger elements of repetitive work including unit turnarounds.

Standardization of Work Methods—Experience has taught that an accurate detailed evaluation of work to be done is impossible when different methods are used to perform the same type of work. Therefore, in order to isolate units of work and provide a common yardstick for measuring extent of work, the most effective method of doing specific craft operations was established and documented. This phase was accomplished through the close co-operation of an industrial engineer and one or more of the most experienced foremen in each specific craft.

All such work was done under the guidance of a thoroughly indoctrinated development engineer of the Mechanical Department. The methods were compiled into volumes called Standard Practice Instruction Manuals (SPI's) and copyrighted. To date SPI's have been developed for the field crafts of welding, pipefitting, carpentry, rigging, exchanger repair, boilermaking, pipecovering, painting, and field machinist.

Training of Supervisors and Craftsmen—Upon completion of the SPI's first line supervisors (job foremen) were trained in the content and usage of the manuals. The training sessions were designed to aid the foremen in understanding the different craft methods and to acquaint them with the sources of needed information.

The SPI's also were used as the basis for the upgrading and improvement training of craftsmen. After de-

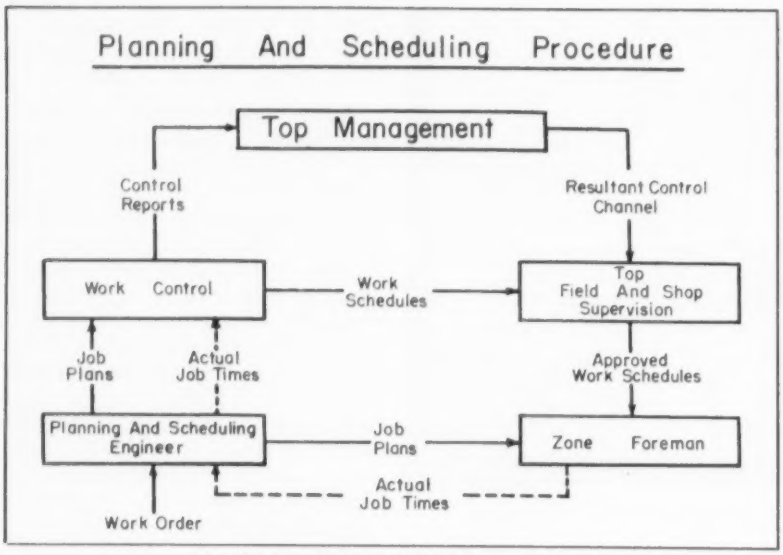

FIGURE 2—Planning and scheduling procedure.

termining training needs through means of craft surveys, the methods contained in the SPI's were adapted to field and classroom training sessions. Within a two-year period all second class mechanics who wanted training and who could meet course requirements were graduated as first class craftsmen. Future needs for first class mechanics will be filled by processing helpers through the SPI based training programs.

Development of Engineered Planning Times—Engineered planning times (EPT's) were established for the standardized craft work methods developed for specific jobs. These times were developed on the basis of all recorded data available and, also, the experience of key first-line supervisors. Again, an industrial engineer worked with the designated supervisors under the guidance of the development engineer. Engineered times for key jobs were field tested in actual productive operations before being released for field planning use.

Zone No. _____ Date _____

	BM	IM	FM	BL	CP	CP	PTR	PP	PC	BG	LB	YD	SQ	MM	W	S	TR			TOTAL	
STANDARD ORGANIZATION																					
BORROWED																					
LOANED																					
VACATIONS																					
OTHER ABSENCES																					
TOTAL AVAILABLE FOR SCHEDULING																					
Priority	Order No.	Description																			Remarks

FIGURE 3—Mechanical department weekly work schedule.

	FIELD, MARINE &ML		SHOPS		TOTAL	
	Scheduled Per Day	Actual Per Day	Scheduled Per Day	Actual Per Day	Scheduled Per Day	Actual Per Day
Authorizations						
Shutdown Work						
Maintenance*						
Absentees						
Total Organization						

*Field Maintenance includes the following manpower:

1. Mech Lab
2. Extended Loans
3. Marine
4. Major Limitations
5. Permanent Assignment
6. Non-critical Crafts

Total

FIGURE 4—Mechanical department weekly scheduled vs. actual manning report—authorizations, shutdowns and maintenance work.

Improvement in Planning and Scheduling Organization and System—While work methods were being standardized and engineered planning times established, the planning and scheduling organization was tailored to make the most effective use of such data in planning and scheduling maintenance and construction work. The present organization as shown in Figure 1 is staffed to perform the following activities:

- To develop and plan routine maintenance jobs in the various plant zones.
- To develop, plan and follow up all unit turnarounds.
- To develop, plan and follow up all authorization work. (These authorizations include construction

work and larger elements of non-repetitive maintenance work).

- To maintain work control through compiling information and scheduling manpower.

The planning and scheduling procedure for work orders is illustrated in Figure 2. Work orders received from various sources are routed through the planning and scheduling engineer. He, in close co-operation with the maintenance zone foreman and the order originator, checks each order, determines when completion of the work is required, notes safety precautions, etc. He then plans the job according to SPI methods and EPT's, prepares charts and sketches, and orders special materials as needed. This engineer has the responsibility for the over-all planning of the job, and he submits the fully developed plan to the zone foreman who has the responsibility for getting the work done. It should be pointed out that in the interest of economy if a job involves five mandays or less of work a guided estimate, based on past performances, is made instead of a detailed evaluation of the extent of the work.

A copy of the developed plan is sent to the work control group where similar information from all zones is compiled. All field manpower is then scheduled for the following week according to a priority listing set up by top management. This schedule is reviewed by top field and shop supervision, adjusted as necessary, and distributed by them to their line supervisors for work performance.

As jobs are worked, the actual times spent on them are routed to the work control group where they are compared with planned times to determine manpower utilization data. Information compiled by this group is forwarded to top management personnel, who are then in a position to exert any guidance or control that might be necessary.

The following are typical examples of some of the reports prepared by the work control group:

- Weekly Work Schedule (Figure 3). This report, which is prepared for each zone, indicates the total number of men available for work during the week and their distribution by type of work. Types of work include top priority authorizations, unit shutdowns (turnarounds), permanent assignments, special maintenance jobs (listed individually), and small daily maintenance jobs. Men assigned to this last type are used for emergencies if the need arises.

Total Jobs	Mandays		P % A
	Planned	Actual	

ZONE	JOB ORDERS				MECHANICAL ORDERS				SHUTDOWNS				AUTHORIZATIONS			
	No. Jobs	Mandays		P % A	No. Jobs	Mandays		P % A	Unit	Mandays		P % A	No. Jobs	Mandays		P % A
		Planned	Actual			Planned	Actual			Planned	Actual			Planned	Actual	
1																
2																
3																
SY																
C																
TOTAL FIELD																

FIGURE 5—Mechanical department weekly field manpower utilization report.

- Weekly Scheduled versus Actual Manning Report (Figure 4). This summary report compares, by type of work, the number of men scheduled with the number of men actually used during the preceding week. A more detailed report (not shown) presents the same information for individual top priority jobs.

- Weekly Field Manpower Utilization Report (Figure 5). A summary report indicating actual effectiveness (planned versus actual manning) for jobs closed during the previous week. (Job and mechanical orders are orders covering different types of routine

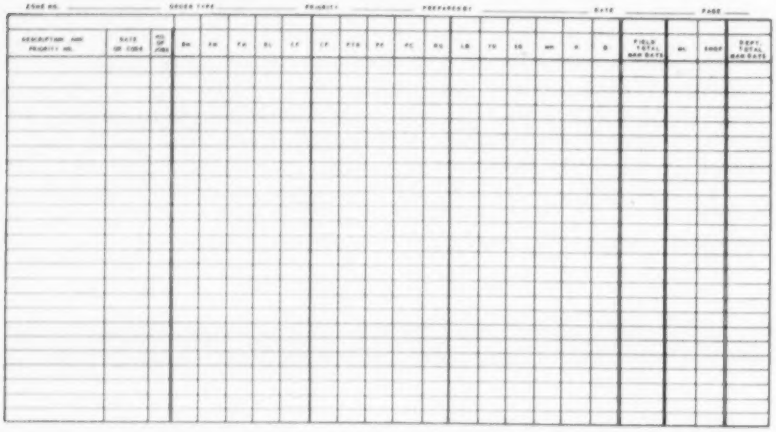

FIGURE 6—Mechanical department craft backlog report.

maintenance work). This same information for each specific job closed is contained in a more detailed report (not shown).

• Craft Backlog Report (Figure 6). A compilation, by craft, of the total number of mandays of work which the Mechanical Department is expected to do in the future. The previous week's backlog and the net change during the week of the report are also included.

Packaging of Larger Elements of Work—It has been learned from experience that planning costs can be reduced by planning larger elements of repetitive work on an EPT package basis. Such elements include unit turnarounds, routine compressor work, tank building and repair, pipe installation, tank painting, etc.

All pieces of an element to be packaged are first EPT evaluated to determine the size of the job. Then the total work load is programmed with respect to most effective gang sizes in order to set up the daily manning and determine the duration of the work. It should be pointed out that provision is made for work additions or deletions while the job is in progress.

Once the job has started the following data are recorded daily on the package plan sheet:

• Actual manpower expended.

• Mandays of work completed each shift.

• Percent of total work completed to date.

• Percent of total work that should be completed to date to finish on schedule.

• Actual manpower used expressed as a percent of total manpower planned.

• Number of mandays ahead or behind schedule.

This information is reviewed daily so that manpower can be shifted as necessary to fit the work load. Manpower is not put on jobs until the work is ready and is removed as rapidly as jobs are finished.

One of the foremost advantages of the packaged plan is that when a complete unit is EPT consolidated the basic plan can be reused with a minimum of effort. Elements of work can be added or deleted as conditions warrant. Such a feature is particularly advantageous in event of an emergency or unanticipated shutdown of a unit.

Experience with packaged shutdowns has not been extensive. However, the results obtained thus far, as tabulated in Figure 7, have been very gratifying. On the basis of such results additional units have been packaged for future turnaround operations.

TURNAROUND COMPARISONS

Unit	% Improvement on EPT Packaged Turnaround*
Combination Cracking	14
Crude Stripper	27
Polymerization, Propane and Gas Purification	26
Combination Cracking	12

* % improvement is calculated by subtracting the number of mandays expended on the EPT packaged turnaround from the average number of mandays expended on former turnarounds of the unit and then dividing by the latter. In some cases more elements of work were performed on former turnarounds than on the EPT packaged turnaround. However, corrections are made for such elements in the above calculations.

FIGURE 7

Cooperation—It should be emphasized that any system of standardized work planning, be it the best system on record, cannot produce the desired results without the complete co-operation of all parties involved. The unlimited cooperation of process operators, inspectors, safety personnel, all staff and service groups, and mechanical personnel working together have made a significant contribution toward the goal of improved manpower utilization and reduced work costs.

ACKNOWLEDGMENT

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Meet the Authors

Newton

Conetta

EDMUND C. NEWTON, with The Atlantic Refining Company since 1936, is administrative assistant in the Mechanical department at the company's Point Breeze refinery, near Philadelphia. His experience in that department includes a variety of maintenance, training and supervisory positions. Before joining the department, he was assigned to the Refining department, first as a process operator and later as refinery engineer. Newton holds an electrical-engineering degree from Cornell University.

MARIO A. CONETTA, mechanical engineer and coordinator in the Refinery department at The Atlantic Refining Company's Point Breeze refinery, joined the company in 1939, after graduating from New York University with a degree in mechanical engineering. Since then, he has served first as process operator and then as mechanical engineer, taking on the additional duties of coordinator in 1951.

How Effective Is Your Maintenance Dollar?

Here are three ways to find out:

- Analyze existing reports.
- Use statistical activity sampling.
- Measure use of activity.

Part 1 - Evaluate Your Current Reports.

Part 2 - Evaluate by Work Sampling.

Part 3 - Evaluate by Craft Measurement.

A. N. Smith
Steinbergs, Ltd.
Montreal

WE USE elaborate methods, both quantitative and qualitative, to measure the raw materials purchased. We scrupulously measure these in various degrees of process. We measure the work of the process worker. In spite of this, we still ignore certain aspects of overhead, which includes the maintenance function.

This would be understandable, if such maintenance expense played only a minor role. But, nowadays, with the era of automation full upon us, it is impossible to ignore the fact that maintenance costs are a tremendous factor in determining the profit picture. If the measurement of production workers, and production materials, is justified, how much more would be the similar treatment of the maintenance worker.

Especially so, when you realize that the effectiveness of the average maintenance organization is only, about, 50 percent. This means we are getting less than 50 cents worth of useful work, in return for our maintenance dollar. Could we use maintenance measurements? Well, you answer that!

You probably feel that this 50 percent figure is quite low. It is! But, why is it low? Are maintenance workers unwilling to work—are they lazy—or what is the answer?

Experience has shown that the following are major factors:

- Improper or insufficient tools and equipment.
- Inefficient location of material and equipment.
- Poor planning and scheduling of shutdowns and of work with other crafts.
- Material shortages and poor material control.
- Inadequate transportation facilities or service.
- Inadequate engineering.
- Inadequate supervision.

Some of you will question whether these factors can make the difference between 50 percent and 80 percent labor effectiveness. Perhaps, we can say that many large industries in the U. S. have found this to be so and let it go with that.

Craft measurement is the technique management uses to combat this ineffectiveness. Briefly, it entails developing standard methods for performing craft jobs and establishing elemental time standards against which work efficiency may be measured. By this technique, better planning and scheduling is possible.

Because of the non-repetitive nature of many tasks, it is not economical to establish individual time standard for each job, as it is performed. In such situations, standard data are used. Standard data may be defined as "the summarized results of many time studies, taken of many operators, by many observers." The accumulation of such standard data is obviously quite expensive. Many plants may not be able to justify such a project.

Standards can be procured by a different technique, one which is in high favor in Europe. This is called "analytical estimating." It is a compromise between the over-all estimating of maintenance work orders and the ultimate of time-studied standards. It goes further than the usual over-all estimating procedure, by requiring the jobs to be broken down into feasible elements, which, in turn, are estimated. Actual times are kept of the element performance to the point where standards may be developed for that element.

All the standard data in the world is useless, unless you have some efficient method of applying them. But, before you do, there are certain prerequisites. These are:

- Adequate organization.
- Efficient work order system.
- Good planning and scheduling control.
- Good maintenance material control.

Adequate Organization There should be an engineer in charge of the program. Preferably, he should have a substantial grounding in work measurement, such as time study, MTM etc. He should be well schooled in the various trades and, as well, possess extreme tact and patience. He should have the personality which will "sell" ideas, without undue trouble.

There should be sufficient analysts or applicators. As these are the kingpins of the entire program, considerable care must be exercised in their selection. It is rare to find an analytically-minded experienced craftsman, with a good work measurement background.

The alternatives are to select an experienced work measurement man, and train him in craft work, or to train a good craftsman in work measurement. The latter seems much more feasible. Training in methods and standards is very important, because much will depend on the analyst's interpretation of the method or standard.

Efficient Work Order System—There should exist a streamlined job order system, which requires all work requests to be written, to be estimated and to be approved before work execution. It should, then, be job-costed and the costs recorded and analyzed.

There should be a distinction between routine and non-routine work, and, between large and small. The appropriate forms should exist for these classifications.

Good Planning and Scheduling—It should be recognized that few maintenance organizations have the surplus man-power necessary to handle all work requests immediately. Therefore, some degree of planning and scheduling should exist to use what man-power you have to its fullest efficiency.

With craft measurement, this planning and scheduling is much more important. You must have time to investigate each order, to analyze it, and to develop the best method of doing the work.

Good Maintenance Material Control—It should not be forgotten that good maintenance is a result of craft skills, tools, materials and equipment, being brought together with perfect timing.

Therefore, all your efforts will go to waste, if poor material control is present. You must have the proper material at the *right* time, in the *right* location, if you are to make full use of it.

How Craft Measurement Works—Let us assume that we have selected a craft for a trial application. Craft measurement will work in this fashion:

- The existing work order system may still be used. This requires orders being sent to our particular craft foreman for his estimations.
- This foreman will separate his orders into large and small. The small, he will handle himself, the large (greater than four hours), he will send to his analyst.
- The analyst takes over the entire paper work here. He will analyze the job, break it into suitable elements and put standard time against each element.
- If design work is required, such as sketches, pipe sizes etc., the analyst will request assistant from the Design Section.
- The analyst enters other details on the order (or on an instruction sheet accompanying the order) such as material list, tools required, safety precaution, etc.
- The analyst issues requisitions for all materials and special tools and equipment and assumes the responsibility for their delivery to the job site, at the required time. This will make it mandatory for him to be acquainted with the scheduling procedures.
- While the job progresses, the foreman alone is responsible for supervision of the job. However, the analyst observes to check on methods and to look for improvement possibilities.
- When the job is completed, the analyst reviews the results.

A major consideration of any undertaking is to gain cooperation from all persons. How can craftsmen, and their supervision, be expected to react to craft measurement? The experience of companies that have installed such a technique have been very favorable. But, of course, you might expect this to be so. In fact, no one should even consider such an installation, unless adequate ground work has been done. This should consist of a "selling" campaign, directed at all members of supervision, as well as payroll.

Craftsmen are usually more frustrated by bad planning than other workers. They take pride in their work and, generally, are interested in improvements. With better planning craftsmen can do their work with minimum interruptions. They know what is to be done, what materials and tools to use and what safety precautions to take. This does not detract from skill, for he alone is charged with doing the work correctly and within the specified time.

Craft supervision is much better off under such conditions. They are relieved of much paper work and are able, therefore, to devote more and more of their time to field supervision. This is very important for there is a definite relationship between worker efficiency and the amount of supervision he receives. At the same time, foremen have some reasonable means of measuring worker performance, and can use these facts to full advantage, both for himself and for the worker.

However, in spite of the rosy picture previously painted, it must be admitted that there are certain hazards inherent in such a program. These can make or break any installations. These are:

- The tendency to over-elaborate in an attempt to foresee all contingencies.
- The failure to recognize that your program is no stronger than your standard data. These must be continually reviewed and revised to keep them up to date.
- The dependence upon human understanding and cooperation. All levels of the organization must understand the objectives, and be properly receptive to them.
- The law of diminishing returns. A point is eventually reached where it is no longer practical to impose further craft measurement techniques because the expense could not be justified by the savings.

Recognizing the pitfalls and understanding the technique, the following facts stand out:

- Successful craft measurement programs have been in use for over 20 years.
- Potential savings are great—before craft measurement, labor effectiveness is low about 50 percent; after, it can be as high as 80 percent.
- It is the recognized authoritative method for measuring the effectiveness of any maintenance organization.
- There is, usually, a great return on the investment. (Sometimes, about 400 percent.)
- It is possible to reduce maintenance costs, up to 40 percent, at a cost of between 5 percent and 10 percent. The reduction in cost is achieved, primarily, by greatly improved job times and, finally, by avoidance of larger crews during periods of increasing production or plant expansion. ##

This is the last of a three-part series.

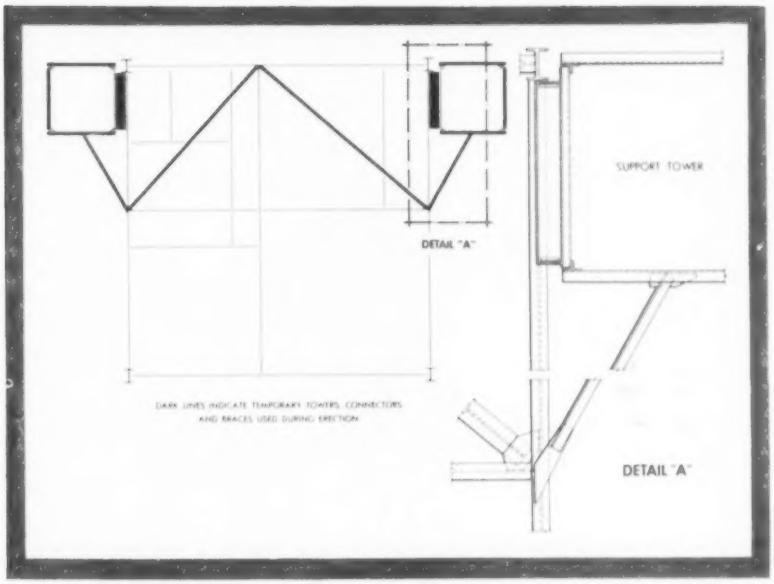


FIGURE 1—Outline of method of tying towers to main structure.

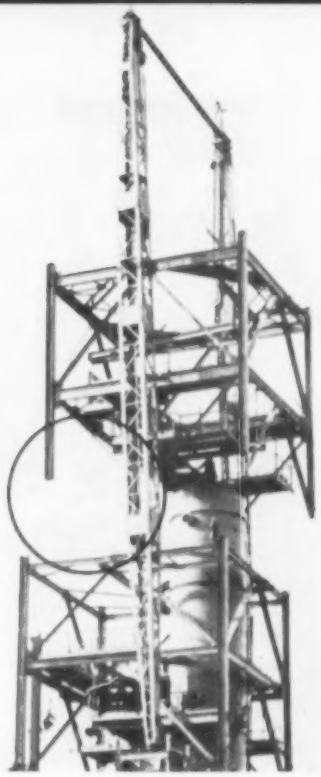


FIGURE 2—Lifting third section of structural steel over reactor.

Here's the story on . . .

How a Rigging Sequence Is Planned

Save time by using this rigging method. Step-wise planning of this technique is discussed in detail.

W. P. Downey
The Fluor Corporation, Ltd., Los Angeles

THIS METHOD of rigging and erecting T.C.C. units should find wide use in similar situations. Developed in 1950 and used many times since, it consistently has cut construction costs and time.

Results of its use prove that the development was sound. Using this method, total elasped time from erection of gin poles to lowering poles after setting the separator surge vessel was only four months.

Master Planning of Operation

In engineering design of T.C.C. units for erection by using gin poles with support towers, it is necessary to plan erection operations and design of the structure at the same time.

The most economical erection procedure uses gin poles of approximately 100-ton capacity and 150 feet long. These poles are supported on towers which allow enough height to erect the separator surge vessel on top of the main structure.

Tower Tie-In Points

Close cooperation between engineering and construction must be maintained during the design of the structure for the T.C.C. unit. Details of erection greatly influence the design of the main structure.

Tie-in points of the support towers must be considered in the design of the main T.C.C. structure. These tie-ins are designed to transfer side thrust stresses or kick from booming operations into the main structure. Figure 1 shows a method of making this connection.

It is essential to tie the towers to the main tructure at each point where the poles rest during lifting operations. A minimum number of pole jumps is desirable. Jumping the poles twice during the erection of one T.C.C. unit where height to top of separator surge vessel was 301 feet is the minimum used by the author.

Check of Clearances

Before plans can be finalized for the support tower tie-ins, a check of all elevations for proper clearances for each lift must be made. One method of checking these clearances quickly and easily is to make a scale drawing of each lifting operation.

Points to be considered are:

- Loads developed during booming operations.
- Maximum height of lift.
- Clearances over obstructions.

The minimum permissable distance between the two main load blocks

FIGURE 3—Lift wings being utilized to raise separator surge.

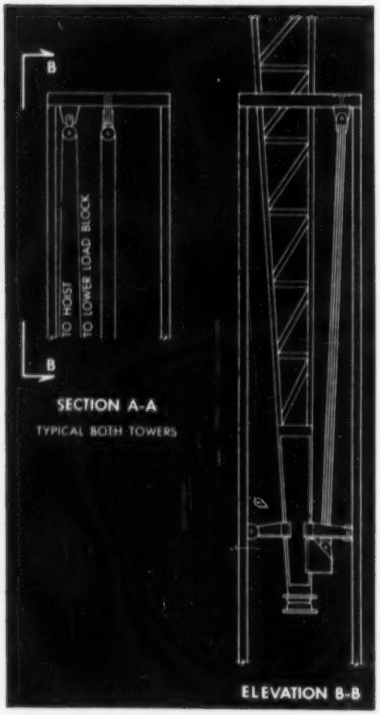
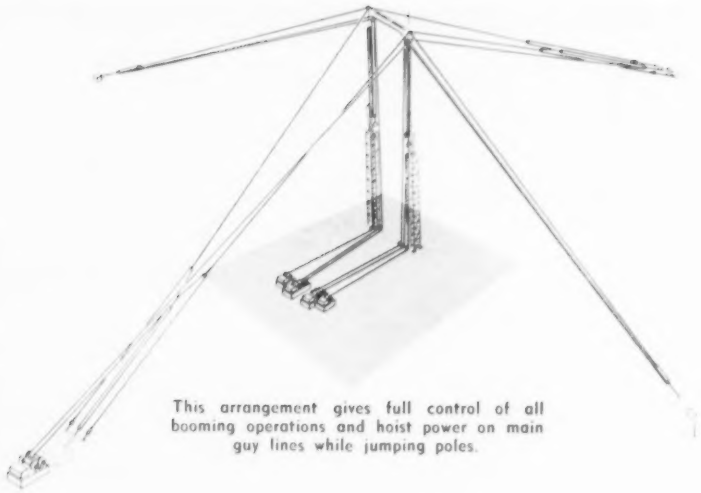


FIGURE 5—Pole jumping hook-up. Method of utilizing multiple blocks and leader blocks for converting load line direction.



This arrangement gives full control of all booming operations and hoist power on main guy lines while jumping poles.

FIGURE 4—Schematic diagram showing locations of poles, deadmen, and hoisting equipment—T.C.C. erection.

Figure 6—Gin poles jumped with base at 90 feet elevation on support towers.

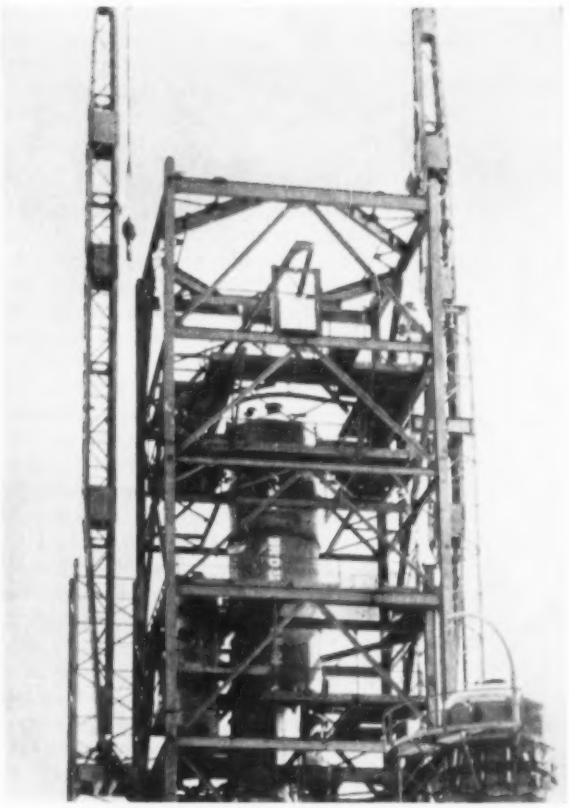


FIGURE 7—Start of erection of support tower, preparatory to jumping poles to 150-foot elevation.

FIGURE 8—View of T.C.C. unit with separator surge in place (note lift wings and support brace on separator surge).

must be maintained to prevent "two blocking."

Figure 2 shows how elimination of cross bracing in the main structure can lower the total height of lift. In Figure 2, the third section of the main structure is being lifted over the reactor. Cross bracing on the back, (left side of photograph) of the structure was omitted to clear the reactor with the least height of lift.

Method of Hooking to Loads

The cost of lifting lugs for vessel and structure as well as the method of attachment must be considered in the planning operations. Many of the hitches must be designed and developed well in advance of use.

A special attachment used for kiln erection was designed for re-use in the erection of the hot catalyst storage bin. This lift beam was designed to be welded to pads on the kiln and after erection burned off and welded to the hot catalyst storage bin shell for erection of that vessel. The beam is scrapped after removal from the hot catalyst storage bin.

In the erection of the reactor, lift lugs welded to the top of the vessel and left in place have been used. The final location of the reactor in the structure will affect the type and design of lifting lugs installed.

Lifting lugs for the structural steel sections are important. These connections must be located above the center of gravity and yet low enough to allow head room for the lifting operations.

The lift connection for the separator surge vessel requires consideration of the forces developed at the top of the lift. To properly protect the shell of the vessel as designed, it is considered good practice to install extensions or wings on the separator surge vessel which could be used in lifting the vessel into place. These wings are installed with sufficient extension from the vessel shell to permit lifting with load blocks in a vertical position which minimizes outhaul at the top of the lift.

The point of lift on the separator surge vessel must be above the center of gravity. The lift wings may be used to lower the gin poles after erection of the separator surge. (Figures 9 and 10.)

Location of Deadmen

Good planning of the erection of T.C.C. units requires a thorough investigation of the location of deadmen. The most acceptable and advantageous locations for deadmen may not be available. Interferences may cause alternate locations to be selected. These should be selected in advance by making a study of the plant site.

Time and labor can be saved by locating the field fabrication area as near the lift area as possible. This will make the shortest possible haul for moving the fabricated items into place for lifting.

An inspection of the site will help in locating erection and fabrication areas. Direction of the main unit on the site will be of prime importance in considering the proposed operation. Direction of the unit means the side on which the elevator and stairway are normally located. It is impractical to lift over such structure and the lifting area should be on the side opposite the stairway and elevators. Lo-

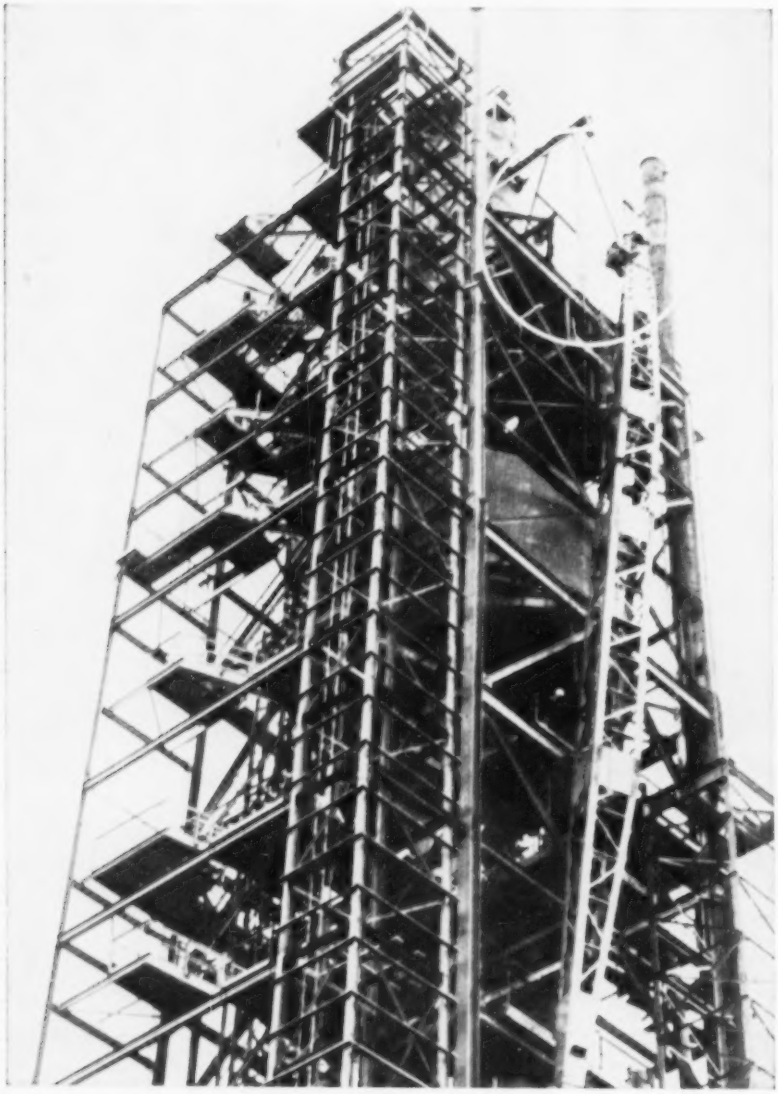


FIGURE 9—Gin pole raised out of tower, preparatory to lowering to ground.

cation of the lifting area in this manner will speed up construction of that portion of the structure and does not prevent the use of such access to the structure.

Minimum guy lengths providing a slope of 45 degrees are desirable. However, in many cases more or less slope can be provided in order to satisfy plant conditions for location of deadmen. In order to eliminate interferences with existing equipment a field check should be made before finalizing the locations of lifting area, deadmen and guy lines.

In finalizing the locations of deadmen, remember that the fore and aft guys move in their own plane during booming operations. The governing consideration in locating these lines is height clearance when poles are at their lowest elevation. This should be thoroughly investigated before locating deadmen.

Side guys move with a fixed point at the deadmen. The ends at the top of the poles move 30 feet to 35 feet in each direction during booming operations. This requires planning for proper clearance of any installation which may interfere with such movement.

Figure 4 is a schematic diagram showing relationships between poles and deadmen with location of hoisting equipment. All of the heights must be given proper consideration as lines will extend in all directions.

Hoisting Equipment

In planning hoisting equipment, consideration should be given to the size of the lifts to properly size the equipment. Hoisting equipment will be required for the main load as well as booming operations and for whip and ground lines.

The size of main load hoists will be determined by the number of sheaves in the load blocks, as well as spooling capacity. Torque converter type hoists with straight line pull in excess of 40,000 pounds and spooling capacity of 5000 feet of 7/8-inch cable have been used successfully. Six-sheave main load blocks have been used and required 4000 feet of cable for main load lines.

Booming operations require considerable study to determine the most efficient arrangement. A two-drum gasoline-driven hoist located at the fore or aft guy deadman has been practical. Luffing lines have been used in the fore and aft booming arrangement to promote ease of operations in handling large loads. Use of a large capacity two-drum hoist would eliminate use of luffing lines.

Two to four additional drums have been provided for other hoisting operations. These may be steam or gas-driven hoists with multiple drums as desired. The type of power available at the job site will determine the hoist drive. Gasoline, steam, and electricity have been used successfully.

Two drums of sufficient capacity for the pole jumping operation must be provided. Six-sheave pole jump blocks with 3/4-inch load line have been used. This operation required approximately 2200 feet of load line and a hoist of sufficient spooling capacity and a straight line pull of 12,000 pounds.

The other hoist drums are for use as whip or ground lines during various stages of operations. These hoists should spool 1500 to 2000 feet of 5/8 or 3/4-inch line and have a straight line pull of approximately 10,000 pounds.

Pole Jump Operations

Figure 5 shows arrangements used for jumping poles in the towers. Guides hold the poles in a vertical po-

sition during the jumping operation.

Figure 6 shows support towers used in erecting T.C.C. units by this method. Towers in this photograph are created with the poles jumped to 90 feet at base.

Figure 7 shows the building of the support towers around the poles before jumping them to the 150-foot elevation.

Support towers are built around the poles. The lifting section is a 15-foot section of support tower with main beam for carrying the load during the jumping operation. The guides are installed on the poles and the load blocks are attached as shown in Figure 5.

At the start of the jumping operation, it is not necessary to have complete control of the guy lines. The gin pole guides will hold the pole in an upright position through a portion of its travel upward.

Before the top guides pass through the top of the lifting section, proper control of fore, aft and side guys must be established and maintained. This requires a coordinated effort of all hoisting engineers operating booming hoists and side guy hoists in order to pay out the lines as the poles are raised through the towers. This coordination may be secured by use of a loudspeaker system and controlled by one rigging superintendent.

Control of Operations

Sound phones from each hoist to the rigging superintendent and from the upper elevation in the structure are desirable. Permit only one man to announce over the loudspeaker to maintain control during these critical operations. Provision for each hoisting engineer to talk to the rigging superintendent by means of the sound phone is recommended; however, all instructions from the superintendent must be given over the loudspeakers.

Lowering Gin Poles

Proper planning for the removal of gin poles is a must for efficient and economical operations. It is possible to lower the gin poles through the support towers in the same manner as they are raised into position, but, a more economical and expedient method has been used in the erection of several T.C.C. units.

Figure 8 shows a view of a T.C.C. unit in which the separator surge vessel with lift wings and the support brace from the wing to the structure installed.

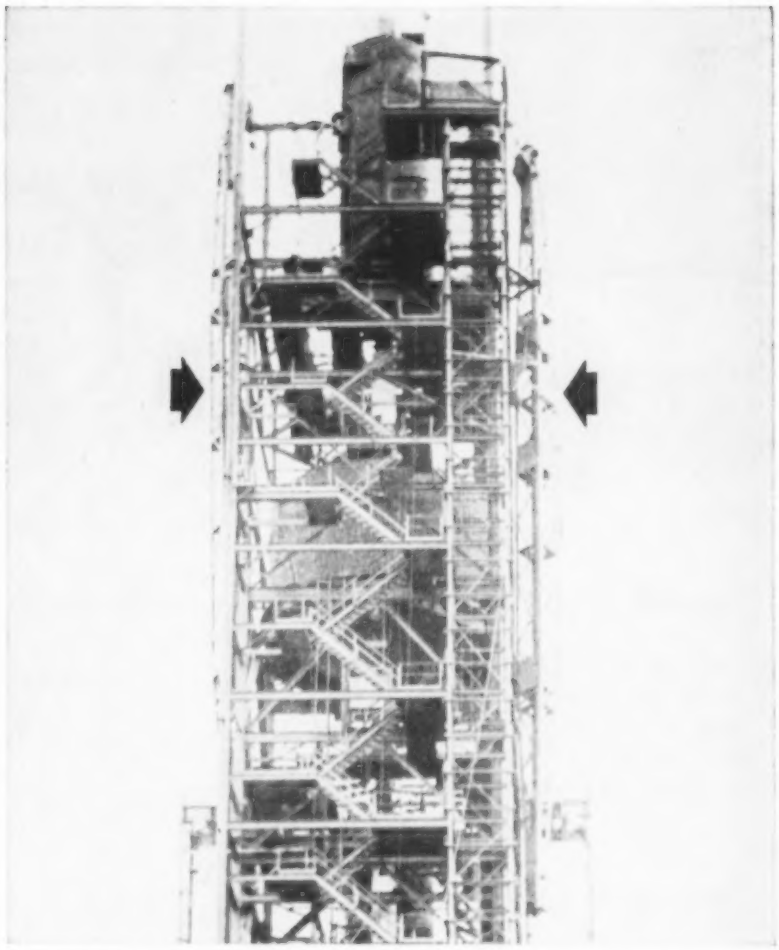


FIGURE 10—Gin poles being lowered after completion of erection of T.C.C. unit.

Figure 9 shows a gin pole raised out of the support tower and on its way to the ground. Note the use of the wings on the separator surge vessel for upper load block in lowering the pole.

Figure 10 is a front view of both poles being lowered simultaneously. One of the poles is slightly ahead of the other.

Notice that at the time the poles are being lowered, the major vessels and considerable piping have been installed. The main structure is complete with most of the piping and miscellaneous equipment installed. The stairwell and elevator are in use.

In addition to the major lifts made, the steam drum, miscellaneous piping, lift pipe, stack, and all steel bracing and cross-bracing were lifted into the structure as part of the day-to-day operations. ##

Meet the Author

W. P. DOWNEY became interested in this subject when he noticed the lack of published material on the rigging used in refinery construction. A vice president of The Fluor Corporation, Ltd., he is in charge of the company's construction division. Downey, who has been with the company 25 years, served as a timekeeper, ironworker, foreman, rigging superintendent and construction superintendent before he was moved into managerial positions. Before rising to vice president, he was manager of Fluor's Mid Continent division.

Wonder What's Ahead?

WHAT'S AHEAD in labor relations? What's ahead in automation? What does labor really think about automation? Possible answers to these and other important industry questions have been "Heard at Meetings."

Keep Going to Page 244.

Everyone Came Out

RAPID TAX write-offs have not caused a concentration of power in the petroleum industry. In "What's Happening in Industry," a Justice Department report shows that the 20 largest companies received certificates in a ratio less than their total productivity.

Keep Going to Page 286.

Keep Up with People

BE SURE to check through "Men in Industry," to see what is happening to people you know, and to people you would like to know.

Keep Going to Page 300.

Just a Few Pointers

THE NEED for a good program of *internal* public relations is brought out in one of the "As Management Sees It" articles this month. Dealing with the everyday relationships within a company, this article has some pointers of interest for everyone interested in the good of their company. **Keep Going to Page 274.**

Job to Run $45 Million

DOW CHEMICAL will spend at least $75 million on construction in 1956. This figure represents a 50-percent increase over the $50 million it spent for expansion in 1955. Of this year's budget, $45 million will be used to expand Dow's Freeport, Texas, plant facilities. For that story, see "Who's Building."

Keep Going to Page 255.

On Fluidization

FLUIDIZATION is the subject of one of the books reviewed this month. Based on a symposium by Polytechnic Institute of Chemical Engineers, this is the first complete book to be devoted exclusively to fluidization and its applications to chemical engineering.

Keep Going to Page 234.

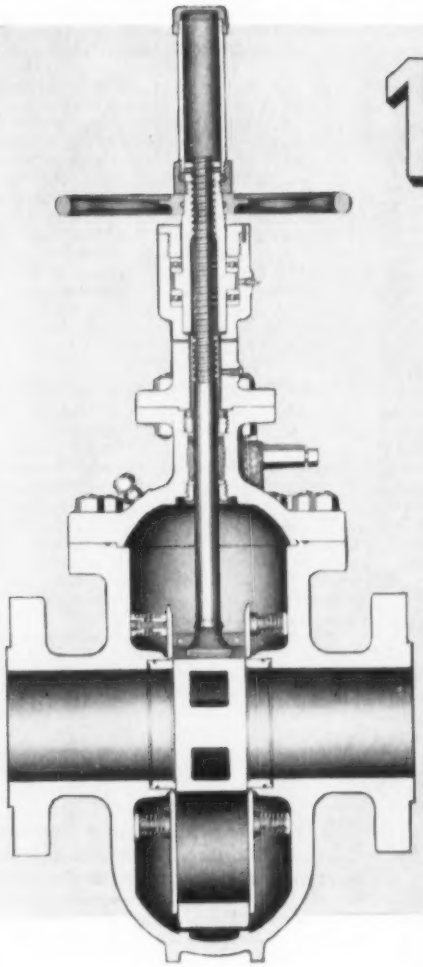
About Suppliers

INFORMATION concerning scores of the people who service and supply the petroleum-refining and allied industries will be found in "Suppliers' Notes." Information you may need to know about the company and its people who serve your plant include personnel changes, extension of facilities, expanding services and new addresses. **Keep Going to Page 236.**

To Make It Easier

DUE TO the similarity of information in "New Equipment" and "Manufacturers' Literature," these two departments have been combined. **Keep Going to Page 336.**

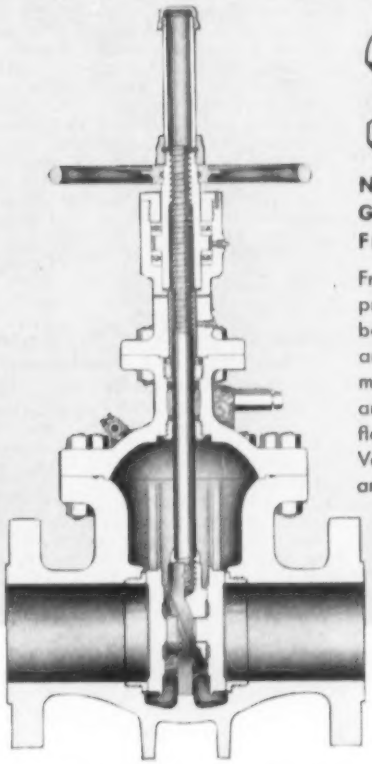
CRANE
Announces Two New
PIPE LINE VALVES



1

NEW CONDUIT-TYPE GATE VALVE
ONE-PIECE DISC; NON-DIRECTIONAL FLOW

Bottom seated, "O" ring-sealed seat rings are self-aligning, and self-sealing on closure—one-piece conduit-type disc uses line pressure for tight seating, does not need excessive stem thrust—spring loaded disc plates prevent loss of grease and entrance of line dirt into body. Sizes, 2 to 30-inch, full-way; venturi patterns also available.



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NEW DOUBLE DISC GATE VALVE WITH FREE-TO-ROTATE DISCS

Free-to-rotate discs distribute wear, prolong life—machined guides in body accurately control disc clearances—annular wedging surfaces maintain perfect disc alignment and compensate for any body deflections imposed by line strains. Valve operation is easier, surer, and maintenance is greatly reduced. Sizes, 4 to 24-inch.

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Another amazing case history

WITH *nalco*

CORROSION AND FOULING

INHIBITORS

THE PROBLEM:

Severe fouling of heat exchangers in a cat cracker absorption oil system where temperatures range up to 575° F.

THE TREATMENT:

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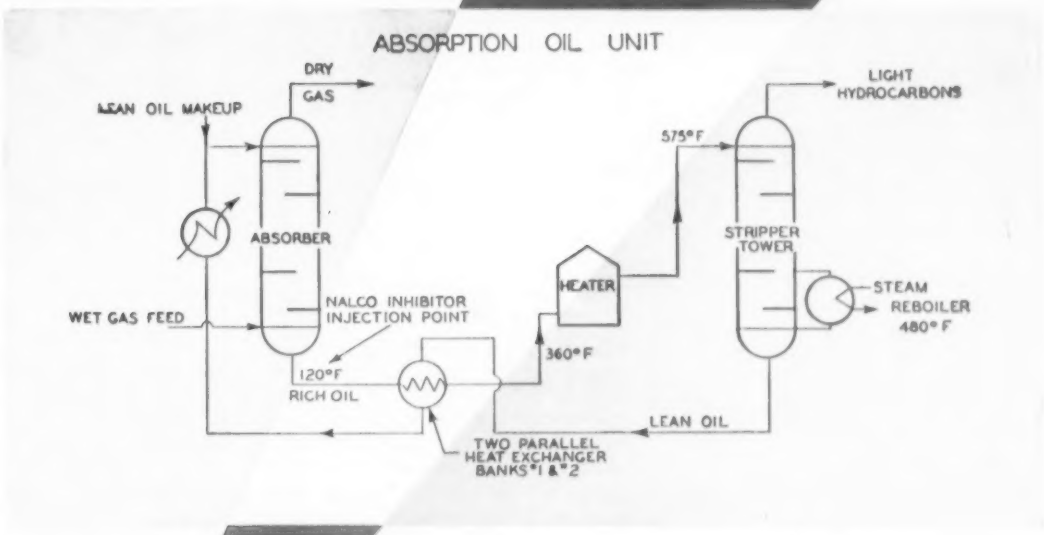

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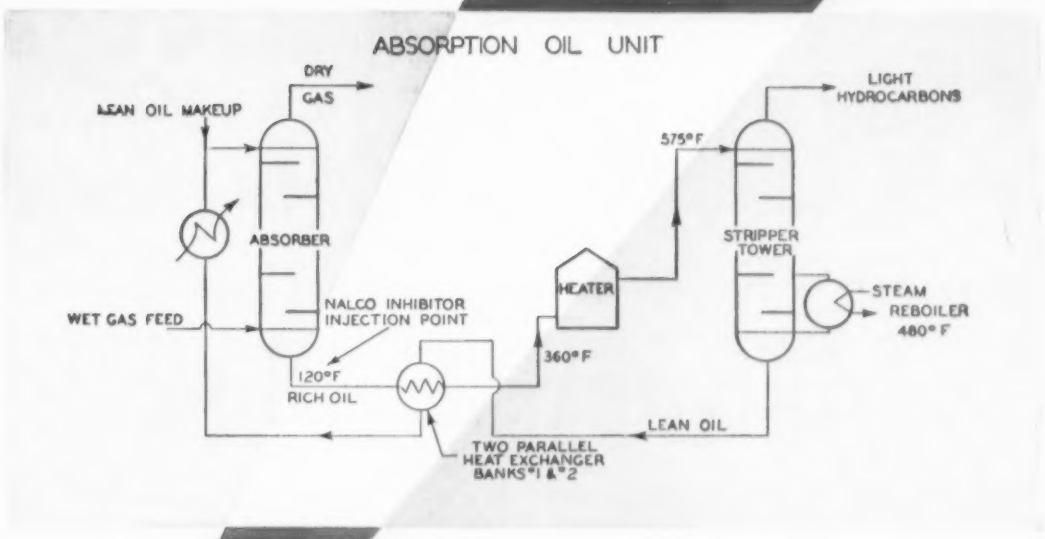

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How To Do It . . .

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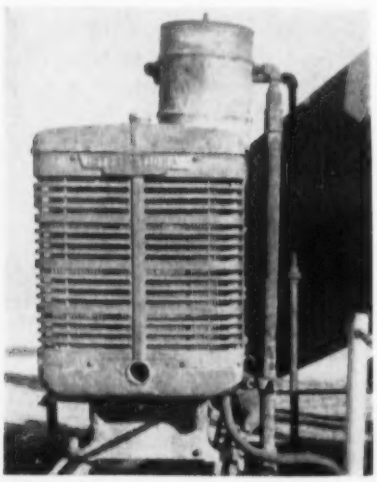
Use Exhaust Heater To Prevent Freeze-Ups

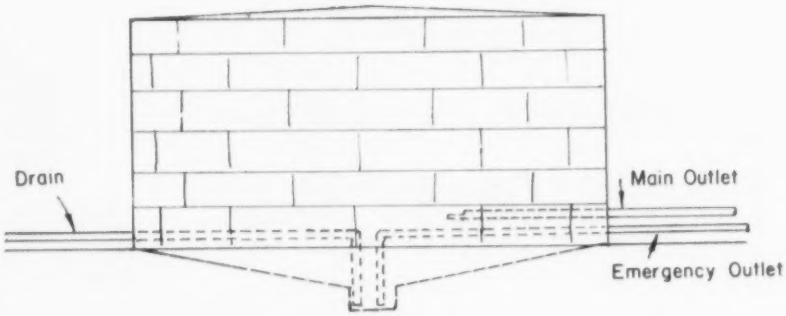
In cases where you have to run a power unit outdoors on tower vapors or other such fuels, you might use this simple rig to keep the regulator on the fuel line from freezing.

Just put a grease drum around the exhaust pipe and set the pressure-reducing regulator inside the drum. The height will have to be adjusted so the diaphragm is kept warm enough so it will not freeze but not so warm it will be damaged.

The whole arrangement can be made by the plant crew, with a little help from a welder. Here are some points to follow:

- Be sure the drum is clean before the torch is applied. A good way is to fill it with inert gas so there is no chance of a combustible mixture inside the drum.
- Cut a hole in both ends of the drum for a one-inch pipe to go through; set the regulator inside and make up the nipples.
- Place the assembly over the power unit exhaust and inlet of the power unit, and nipple up the discharge lines.
- If more than one unit is fed off the same regulator, lead the line back to the ground (as shown), and let it take off at the engine's working pressure.





New Design Makes Full Use Of Plant's Tank Facilities

One of the newest developments in tank building is to make the bottom of a large tank an inverted cone. This allows the drain to pickup material over a small area, instead of many square feet.

The bottom can be laid out so that it slopes toward the center, with a cup in the bottom for the drain. Just a few inches above the drain line another line can be installed inside the cup. This second line can then be tied back into the main outlet line leading to the loading point.

Before taking the top gage, the bleeder is checked, and an analysis is run on the settlings in the bottom. When the big tank has been drawn down to the shut-off line and a few more thousand gallons are needed for loading, a sample is taken again from the drain cock. If the sample is all right, the load is finished from the lower line.

Here Are Some Pointers On Tank Maintenance

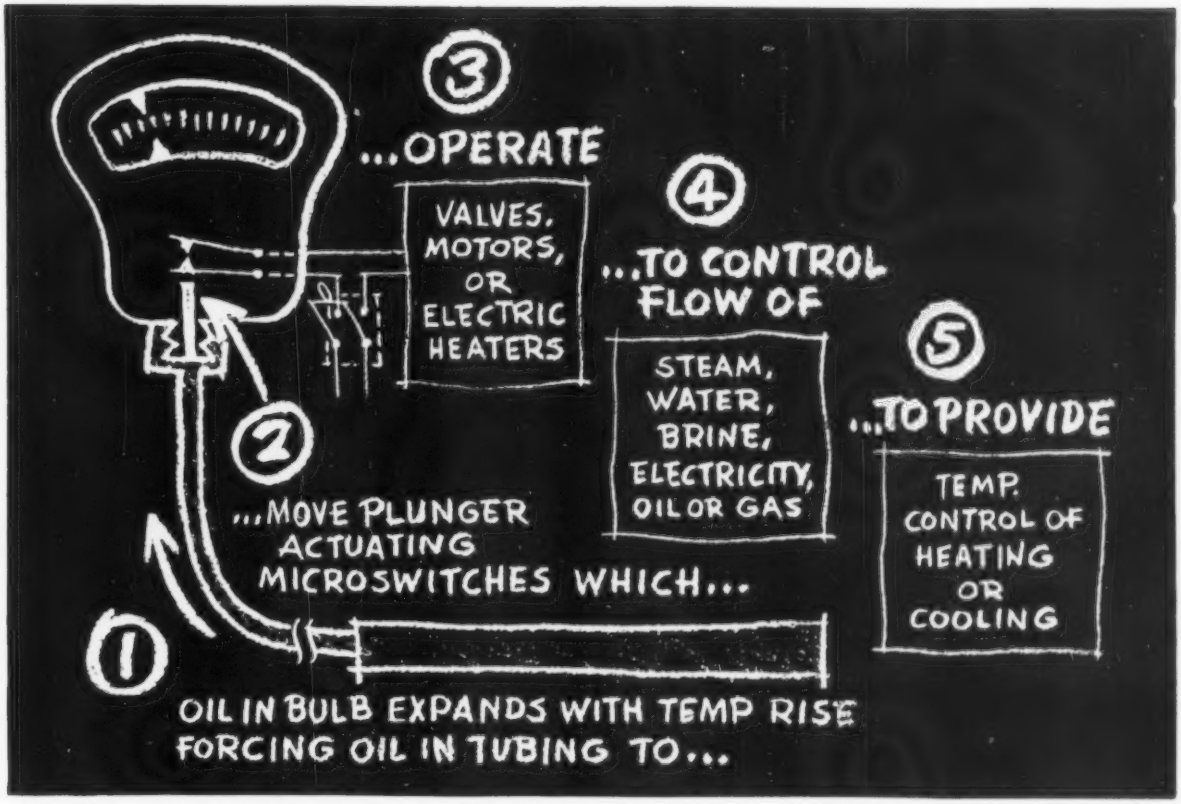
Storing chemicals in glassed steel tanks presents several special maintenance problems. Here are some pointers on how to get the best performance:

- When entering the tank for repairs or inspection wear sneakers, rubber soled footwear, or heavy socks to cover shoes which may have exposed nails.
- Lay down a protective blanket or padding on the base of the tank on which to walk.
- Secure all repair tools brought into a glass lined tank so they will not drop accidentally. Bring only necessary tools into tank.
- Make inspection of tank on a regular schedule and make necessary repairs, if any, promptly.
- Avoid subjecting tanks to sudden changes in temperature.
- Keep outside surfaces of tanks painted with protective paint. Corrosion can also work from the outside in.

Place Relief Valves For Easy Checking

In plants where several tall fractionating towers and stills are used and the relief valves are on top, the problem of keeping valves checked and serviced may become complicated. Since large lines are used to carry gas from the top of the towers, a more convenient place for the valves is near the ground.

In one refinery, the outlet line is run to the top of the tower to vent any escaping gas. No valves are placed between the RV and the tower



INDICATING
Automatic Temperature Control

It's simple...dependable!

That rough sketch above tells the story. It shows Sarco's simple electric indicating temperature control . . . and what it can do for you.

Really mighty simple, isn't it? Yet, it's adjustable, indicating and provides dependable accuracy to ± ½°F. No gadgets that call for a technician to read and repair! So simple, so trouble-free . . . maintenance is seldom, if ever, needed.

Turn one knob to change the temperature control setting. Large, easy-to-read scale shows you both the actual and the set temperature.

SEQUENCE CONTROL

And this Sarco electric temperature control is versatile . . . it offers you many sequence combinations such as:

- **Step-heating**
- **Heating and cooling**
- **Wide limit control**
- **Temperature control plus operation of signal devices**

Cost . . . only about $100! It's good economy to specify AUTOMATIC temperature control for ALL control jobs, not just the big ones. So mail the coupon now for complete information.

SARCO

Sarco Company, Inc., Empire State Bldg., New York 1, N. Y.

Please send information on your simple, inexpensive temperature controllers:

☐ Self-powered type for use on _____

☐ Electric indicating type for use on _____

Name _____

Firm _____

Address _____

City _____ State _____

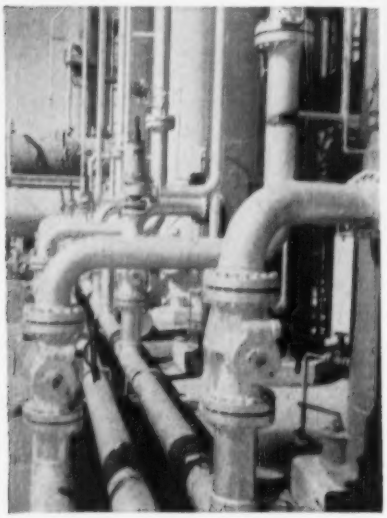
2147-B

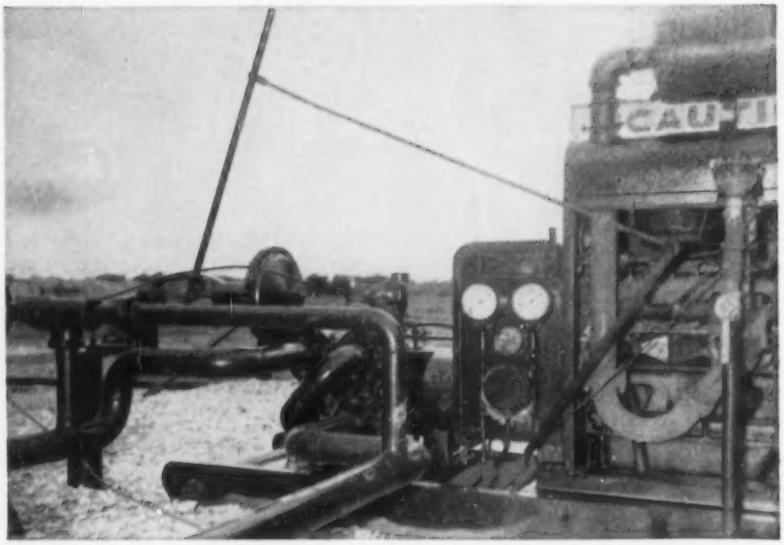
For more data on advertised products, use Readers' Service Cards, last page

How to Do It...

top lines so the relief valves always will carry tower pressure.

By using flanged relief valves, it was possible to arrange the piping so that any tower could be taken out of service for a few moments and the relief valve replaced without going to the top of the tower.





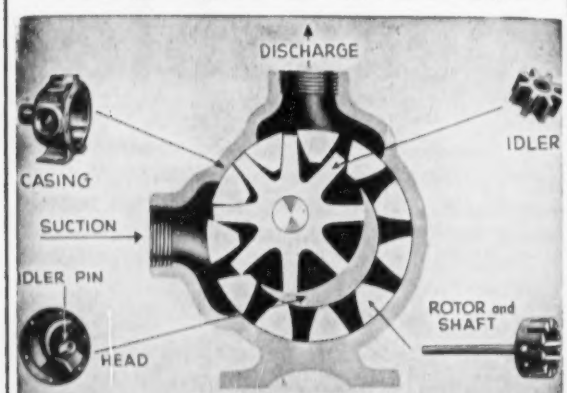
Regulate Engine Speed By Using a Diaphragm

It is difficult to keep the necessary power output with an engine governor, when the discharge pressure of a pump varies from atmospheric pressure to several pounds. The result is an engine running too fast under light loads.

An arrangement has been made by installing a diaphragm on the pump outlet and running a rod to the gas inlet on the manifold of the carburetor. A check valve was placed in the by-pass line around the pump.

The fluid flows through the valve,

Viking Operating Principle



Above are illustrated the major parts of the Viking Pump—casing, head, rotor and idler, separately and assembled. Imagine the rotor and idler in motion operating in a counterclockwise direction. Follow the course of the liquid from point of suction to point of discharge. Reverse direction will operate equally well. We invite your inquiries.

DISTRIBUTORS

SOUTHERN ENGINE & PUMP COMPANY

MANUFACTURERS • MACHINERY FACTORS • CONTRACTORS

Houston - Dallas - Kilgore - San Antonio - Edinburg

Corpus Christi and Beaumont, Texas.

YOU CAN CHANGE LINE BLINDS THIS EASY WAY WITH THE NEW

GREENWOOD GATE VALVE LINE BLIND

★ No bolts to loosen!

★ No lifting of plates!

★ No spreading of line!

• Revolutionary design . . . makes this gate valve line blind simplest and easiest to operate . . . with greater economy and dependability. Just turning the hand wheel raises the blind plate from the valve body into line with a machined carrier track incorporated in the top of the valve yoke. Here the blind plate merely slides off the stem onto the carrier track, and the other blind or spectacle plate is then slid onto the valve stem and lowered into position.

Write for full details today!

PATENTED

• LINE BLIND is positive as a shut-off blind because it has metal-to-metal seats between the wedge and valve body as well as "O" ring seal.

GREENWOOD VALVE DIVISION

VERNON TOOL CO., LTD.

1101 MERIDIAN AVENUE • ALHAMBRA, CALIFORNIA

Catalysts

Require stability, too . . .

and with Davison's *LOW DENSITY* catalyst you get commercially proven higher stability. You get a higher degree of thermal stability without affecting the resistance to attrition or other proven qualities of Davison catalysts. Commercial fluid cracking units, operating for over one year, demonstrate that this stability leads to:

Higher surface area—Higher pore volume—Higher pore diameter—Higher catalytic activity—Improved regeneration

This new *LOW DENSITY* catalyst is yet another Davison catalyst manufactured with controlled catalyst characteristics. At Davison you can get the catalyst best suited for your unit. For information on Davison's new *LOW DENSITY* catalyst, as well as other Davison catalysts, see your Davison representative or write.

Progress Through Chemistry

DAVISON CHEMICAL COMPANY

Division of W. R. Grace & Co.

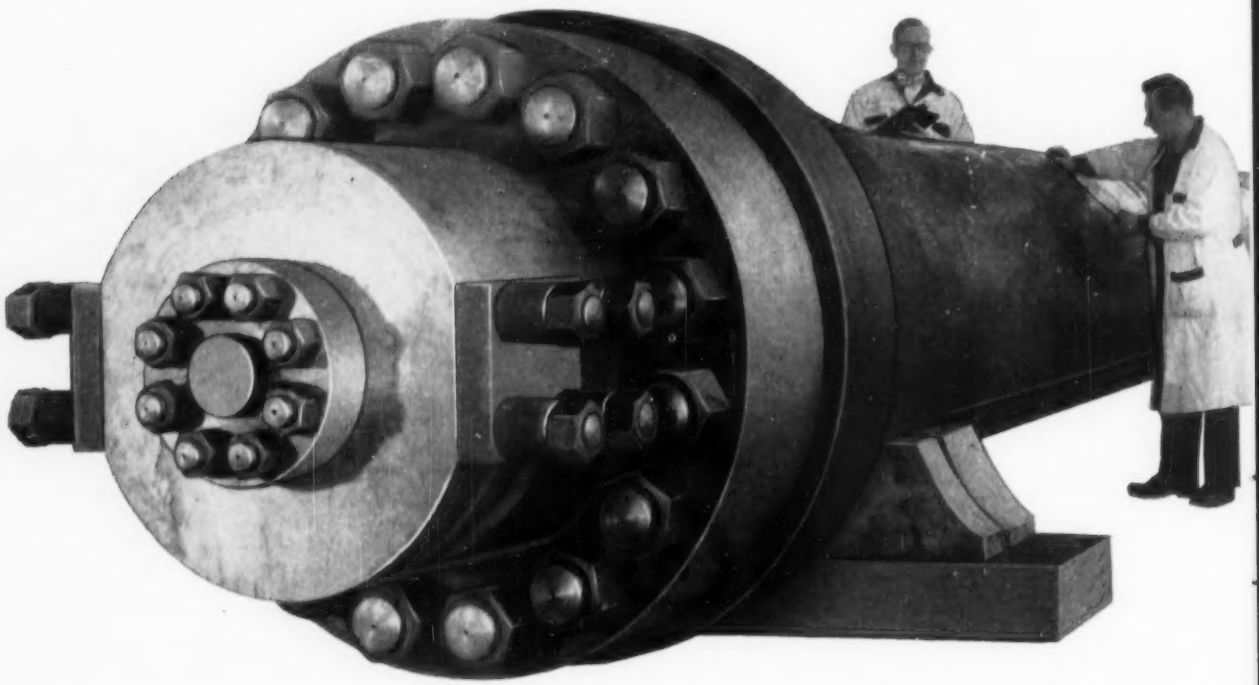
Baltimore 3, Maryland

Sales Offices: Chicago, Ill.; Houston, Tex.; New York, N. Y.; Baltimore, Md.
In Canada: Davison Chemical Company Ltd., Toronto

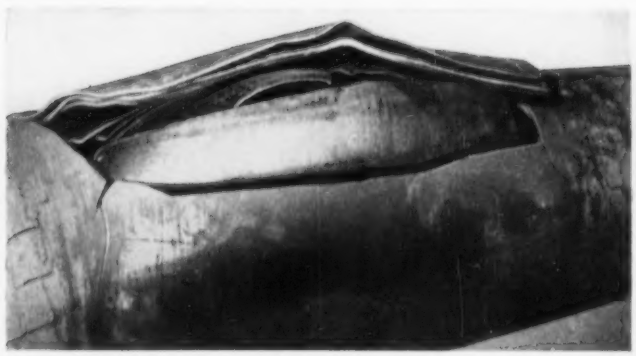
PRODUCERS OF: CATALYSTS, INORGANIC ACIDS, SUPERPHOSPHATES, TRIPLE SUPERPHOSPHATES, PHOSPHATE ROCK, SILICA GELS AND SILICOFLUORIDES. SOLE PRODUCERS OF DAVCO® GRANULATED FERTILIZERS.

For more data on advertised products, use Readers' Service Cards, last page.

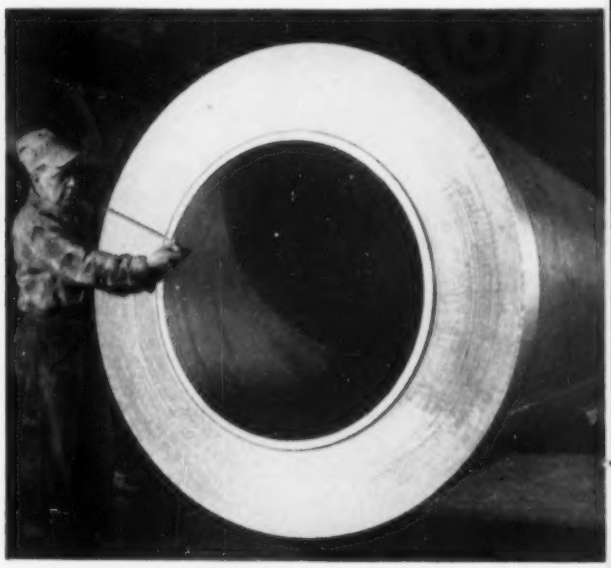
8000 pressure vessels ...



MULTI-LAYER AMMONIA CONVERTER
Built for operating pressures of 12,500 psi. . . . test pressures of 18,750 psi.
Wall thickness 9 15/16 in. . . . I. D. 25 3/16 in.
Overall length is 44 ft. Weight 238,000 lbs.



SAFETY — Nearly 8000 MULTI-LAYER vessels in operation — and not a single failure — certainly convincing proof of the safety inherent in this unique A. O. Smith design. To further prove operating safety, we have actually tested many full-scale, high-pressure MULTI-LAYER vessels to destruction. In every case, vessels rupture without shattering or fragmentation.



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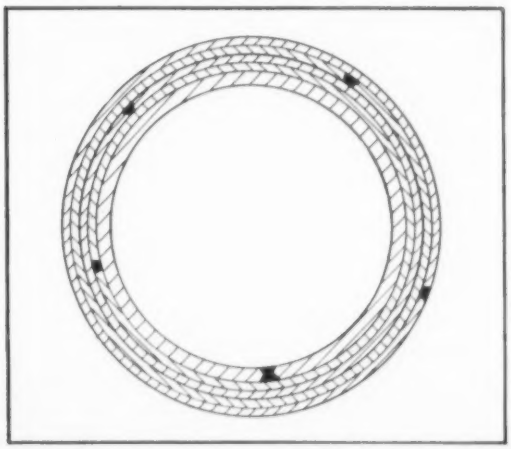
...8000 reasons why you can depend on exclusive MULTI-LAYER CONSTRUCTION

FOR SAFETY

FOR ECONOMY

FOR FLEXIBILITY



ECONOMY — Savings start with fabrication. Instead of using thick plate in a single wall, MULTI-LAYER vessels are built up from concentric layers of relatively thin steel plate . . . progressively wrapped, tightened and welded together around an inner, pressure-tight cylinder. No need for costly stress-relieving in field assemblies. And for corrosive operations, only the inner shell requires special alloys.

FLEXIBILITY —With MULTI-LAYER, there's no limitation of size or weight for your vessel design. You can design for higher pressures, too. Walls can be made stronger simply by increasing the strength of the steel used or by adding more layers. Since shell sections can be welded together in the field, vessel length is not limited.

See how A. O. Smith's exclusive MULTI-LAYER construction can provide safety, economy and flexibility in your own operations. Write our nearest office. We'd be happy to provide more detailed information about MULTI-LAYER construction for high-pressure vessels.

Through research A.O. Smith *...a better way*

A.O.Smith
CORPORATION

PROCESS EQUIPMENT DIVISION

Milwaukee 1, Wisconsin

Chicago 4, Illinois • Cleveland 15, Ohio • Dallas 2, Texas • Denver 2, Colorado • Houston 2, Texas • Los Angeles 22, California • Midland 5, Texas • New Orleans 12, Louisiana • New York 17, New York • Pittsburgh 19, Pennsylvania • San Francisco 4, California • Seattle 1, Washington • Tulsa 3, Oklahoma • Washington 6, D. C.

INTERNATIONAL DIVISION: Milwaukee 1, Wisconsin

Licensee in Canada: JOHN INGLIS CO., LTD.

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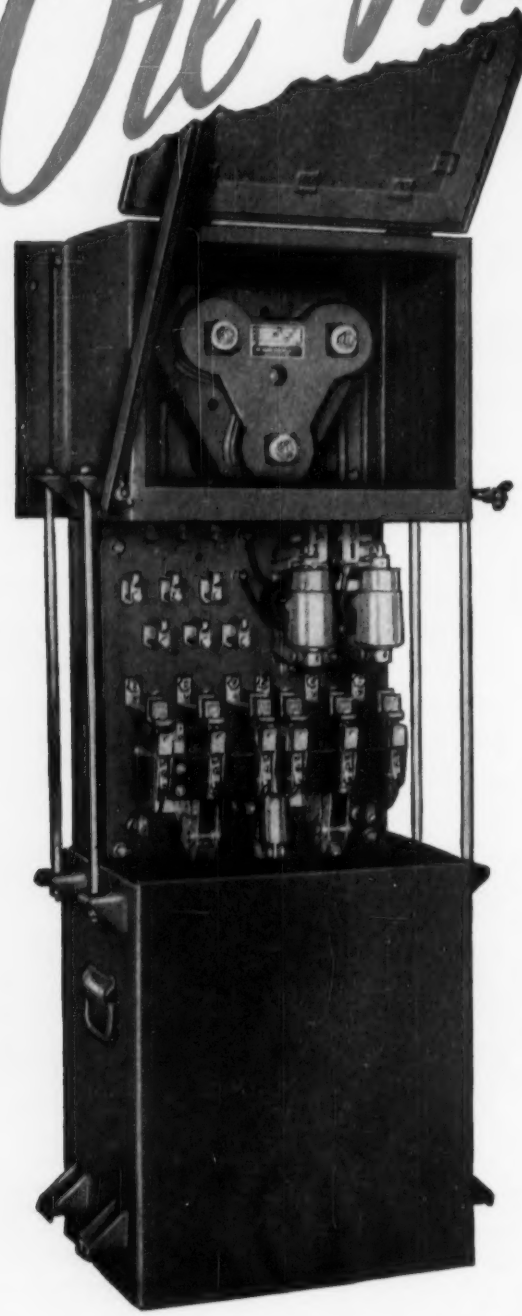
Oil Immersed

REDUCED VOLTAGE STARTER OF THE IMPEDANCE TYPE

900 Series



Type 900-B, Frame 100, Reduced Voltage Starter of the Impedance Type

Push button operated—fully automatic—Rowan 900 Series, oil immersed, reduced voltage starters of the impedance type give your induction motors a smooth start with a minimum of line disturbance.

The 900 Series starters include such features as: a closed transition, utilizing for acceleration a combination of voltage and time; an acceleration period dependent upon driven equipment and load, which eliminates the human element; continuous wound impedance coil assures freedom from tap failures—impedance is adjustable to each application; magnetic overload relays provide a combination of inverse time element and instantaneous operation.

Combination starters include: Rowan time-tested AIR-SEAL fuses providing dependable short circuit protection; sealed-off centralized wiring compartment; provision for straight through conduit connections; tank and disconnect mechanism mechanically interlocked to prevent the lowering of the tank before disconnecting the line disconnect switch.

Enclosures are of weather-resistant design to meet NEMA Type XI requirements and are available also for NEMA Type VIII, Class I Group D locations.

ROWAN CONTROL

THE ROWAN CONTROLLER CO., BALTIMORE, MD.

How to Do It . . .

and when the pressure builds up the diaphragm closes the throttle on the power unit. As long as the line is operating under a vacuum, the engine runs at idling speed. When the pressure builds up, the throttle opens on the engine, and fluid is put through the line to the tanks.

Use a Gasoline Drum To Support a Fan

For engine rooms or shops which must have additional ventilation, a gasoline drum can be converted to a stand for the fan. Here how:

A notch is cut in one side of the top, and the top section of another drum is cut out to form a guard for the fan. The fan motor is fastened to a plate which fits inside the top of the drum.

Handles should be welded to the side of the drum so it will be easier to move.

The switch to operate the fan is in a well cut between the drum's two middle chimes. An insulated wire leads from the switch, through the drum, to the fan motor.

This fan can be placed conveniently near any engine that might be overheating, or it may be turned toward the work bench.

ONE OF THE GARLOCK 2,000

SERVICE REPORTS ON THIS PACKING EVEN SURPRISED US!

Typical Service Reports on Lattice Braid Asbestos Packing with Teflon:

- Outlasted another Garlock Style 10 to 1 against blending waxes and steam for cleaning.
- Outlasted competitor's packing 38 to 1 against caustic at 325°F., 50 psi.
- Outlasted other packings 3 to 1 against cold water.

Don't take our word for the greater strength, longer life of LATTICE BRAID with Teflon—try an initial order of 10 or more feet today. The Teflon core and impregnation resist everything except molten alkali metals and some freons.

And, remember, LATTICE BRAID with Teflon is only one of the Garlock 2,000 . . . two thousand different styles of packings, gaskets, and seals to meet every conceivable need. It's the *only* complete line available. It's one reason why you can expect unbiased recommendations from your Garlock representative. Call him, or write for booklet 131.

THE GARLOCK PACKING COMPANY,
Palmyra, New York

For Prompt Service, contact one of the 30 sales offices and warehouses throughout the U.S. and Canada.

GARLOCK

Packings, Gaskets, Oil Seals, Mechanical Seals, Rubber Expansion Joints

For more data on advertised products, use Readers' Service Cards, last page.

What's Ahead in Labor Relations*

If it is true that coming events cast their shadows, anyone concerned with the labor-relations picture is in for a very active program since the shadows are many and some are growing longer.

Lending substance to these shadows are such items as the guaranteed annual wage and its current partially attained manifestations, the principle of automation as revived and applied to the mid-twentieth century business structure, the refurbished productivity theory of wages with its perennial debate as to the appropriate share imputed to each factor of production, and the recent merger of our major union organizations with the manifold political and economic implications of such action.

Each of these items warrants examination as to the rationale of its background, pros and cons, for its existence, cumulative steps in its development, and its major portent for the future. (Carrol K. Ward, Consumers Cooperative Association.)

Full Automation Ready for Industry*

Equipment is now available for converting analog signals representing process variables into digital values which can be automatically logged at periodic intervals to produce an accurate digital record of process operations.

Data can be manipulated and computations performed by the data-handling system to yield the desired final form for the digital information. Final presentation of the data in a variety of forms such as log sheets, paper tape and punched cards, is possible.

Advantages of the automatic data-handling system lie in the fact that the system can do more than the human operator and do it better. Speed and accuracy of logging, versatility of output, automatic simultaneous computing, alarm scanning and other features contribute to more efficient and safer process operation, with better cost control and analysis of process operation provided for management.

Better utilization of space and manpower through use of automatic data handling equipment permits centralized control of multi-plant operations. (J. F. Smith, Minneapolis-Honeywell Regulator Company.)

Your Benefit Plan; Its Administration*

These seven important points should be kept in mind in the administration of any successful benefit plan:

1. Let the SUPERVISOR drive the benefit-plan car.
2. Plans should apply UNIFORMLY to everyone.
3. Do not take advantage of a TECHNICALITY.
4. Advise an employe of HIS RIGHTS under the plan.
5. Resolve the doubt in favor of the EMPLOYE.
6. Use the CONSULTATIVE approach.
7. Keep the plan SOLD.

[J. C. Hurley, Standard Oil Company (Indiana).]

Boron Can Reduce Surface Ignition*

A boron component effectively reduces surface ignition in gasoline engines without itself accumulating in the engine. It reduces deposits on hotter areas and thus lengthens exhaust valve life.

Of particular interest to refiners, it is shown that a boron component increases the F-1 anti-knock effect of tetraethyl lead in most gasoline. The effect varies widely with fuel composition. Ratings on the road show the anti-knock effects to be better than predicted by the F-1 measurement.

The boron component counteracts in part the bad effects of sulfur compounds on TEL. The compound is of low toxicity and easily injected into the gasoline. [Dr. E. C. Hughes, The Standard Oil Company (Ohio).]

Test Fluids For Autoignition†

The presence of any appreciable quantity of ignitable fluid always constitutes a fire hazard. To eliminate this hazard, industry has for years sought non-flammable materials for use as hydraulic fluids, cutting fluids, cleaning fluids, and hosts of other applications. Many fluids have been offered as non-flammable . . . others as fire-resistant.

Often these have been used with no thought that they might constitute a fire hazard while, in fact, they may be ignited . . . or autoignited . . . with comparative ease.

This discussion dealt with conditions under which many fire-resistant materials become fire hazards. Autoignition tests of chlorinated and fluorinated hydrocarbons were described to show how pressures and temperatures make these materials burn readily. The influence of hot surfaces, ignition sources, material break-up (i.e., spray or pool) also were discussed.

The real significance of volatility in affecting flammability is often misunderstood, so the discussion touched upon the role of volatility in mitigating . . . or abetting . . . an ignition hazard. (R. W. Hurn, U. S. Bureau of Mines.)

Automation Here; Just Still Growing†

The recent emphasis given to the word Automation, has created a great deal of ill feeling toward any undertaking associated with the word. The tendencies of the press to suggest that this "new" principle is ready to take on all of our daily tasks makes us fear for the security of our jobs.

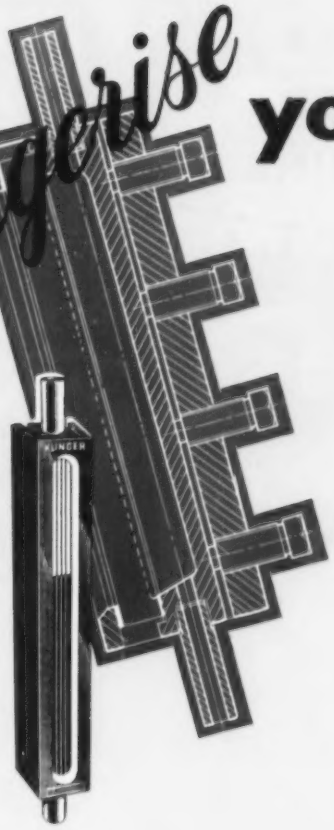
A group of 1000 factory workers were asked whether they wanted improved machines. They voted yes by a majority of 3 to 1. At the same time, about 60 per cent of the same group voted against automation.

The principles of automation have been incorporated into our daily lives ever since the industrial revolution. We must continue to use these principles to fill the gap between the large increases in the demand for

* WPRA, Houston.

† Symposium on Instrumentation for the Process Industries, College Station, Texas, January 25-27

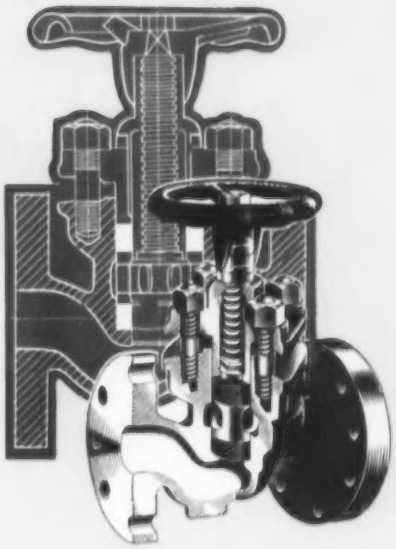
Klingerise your plant



REFLEX LEVEL GAGES

The "K" Type Reflex Level Gage has the following outstanding advantages:—

Single row of tightening bolts. Body free from distortion. Glass easily removed. Gage body turnable, free to expand, and easily removed.



SEATLESS PISTON VALVES

The Klinger Seatless Piston Valve operates on an entirely different principle from the usual type of seating valve. It consists basically of a finely ground piston, operated by the valve spindle and hand wheel, and moving through two or three non-metallic resilient valve rings, capable of resisting steam, oil and most fluids at high temperatures and pressures, and separated by a ported lantern bush. It is made in a great variety of sizes and designs, to suit all purposes, and has the following advantages:—

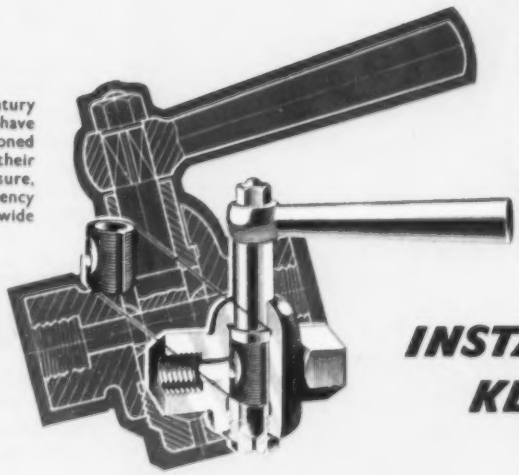
No seat—consequently no regrinding. Can be serviced in the line. Unaffected by wiredrawing. Unaffected by throttled use.

SLEEVE-PACKED COCKS

In the last quarter of a century Klinger Sleeve-Packed Cocks have steadily replaced the old-fashioned asbestos-packed cocks with their limitations of working pressure, difficulty of repacking, and tendency to jam. They are available in a wide range of designs and sizes for all purposes, and with the following advantages:—

Renewable "Klingerit" packing sleeve. Retightening during use. Parallel-ground non-jam plug. Unobstructed straight-thru full-bore passage.

Write for the Klinger Master Catalog which describes the complete range of Klinger products.



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RICHARD KLINGER LIMITED, KLINGERIT WORKS, SIDCUP, KENT, ENGLAND

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MANUFACTURERS OF KLINGER SEATLESS PISTON VALVES; KLINGER SLEEVE-PACKED COCKS; KLINGER LEVEL INDICATORS; RINGS AND SEALS IN KLINGER SYNTHETIC MATERIALS, AND KLINGERIT COMPRESSED ASBESTOS SHEET JOINTINGS AND PACKINGS FOR EVERY PURPOSE

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Another New
WILLIAMSON - HILLCO
TAPPING MACHINE
EASY ACTION CLUTCH*
AUTOMATIC CUTTING FEED
HEAVY DUTY BEARINGS
HAND POWERED OR WITH AIR MOTOR DRIVE
MODEL 360
PIPELINES • CHEMICAL PLANTS
REFINERIES • STEEL MILLS
For making high pressure, high temperature taps into piping and tanks WITHOUT SHUTDOWN
• 24" BORING BAR TRAVEL PERMITS . . .
PIPE TAPS TO 6"
TANK TAPS TO 6"
MAXIMUM OPERATING PRESSURE
1,440 PSI AT 100° F.
MAXIMUM TEMPERATURE
700° AT 700 PSI
EACH MACHINE TESTED TO: 2,175 PSI
SELF ADJUSTED CHEVRON PACKING*
INTEGRAL FLANGE FORGING*
ASA - 600# RTJ FLANGE
CHROME PLATED BORING BAR
*NEW FEATURES FOUND ONLY IN 360 MACHINE WHICH SUPERSEDES MODEL 300
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REPRESENTATIVES: Houston • Pittsburgh • Plainfield, N. J. • Amarillo • Casper • Provo, Utah • Joliet, Illinois • Los Angeles • San Francisco • Bartlesville, Okla. • Edmonton • London, Ontario • Calgary • Buenos Aires • Durban, Natal, South Africa

goods and services and the insufficient increases in available workers.

The attempts to ban automation are similar to the story concerning the economist who introduced a motion to prevent the sharpening of axes. He argued that cutting down trees with a dull axe would require more labor—hence more jobs.

We can not afford this kind of self imposed inefficiencies. (D. B. Campbell, E. I. du Pont de Nemours & Co.)

How to Develop* Managerial Talent

The development of managerial talent is required for a company's continued success. It is a part of management responsibility to concern itself with the systematic and continuous supply and improvement of management personnel. This will assure a strong, effective and increasingly competent management organization.

The tendency to formalize a management function has resulted in many problems. This discussion dealt with how management appraisals can be kept from being treated superficially apart from day-to-day management; how counseling can become more than a "telling" activity, and how to build in better accountability and control measures to this vital management function. (Richard R. Crow, Continental Oil Company.)

Stresses Importance Of Rigid Inspections*

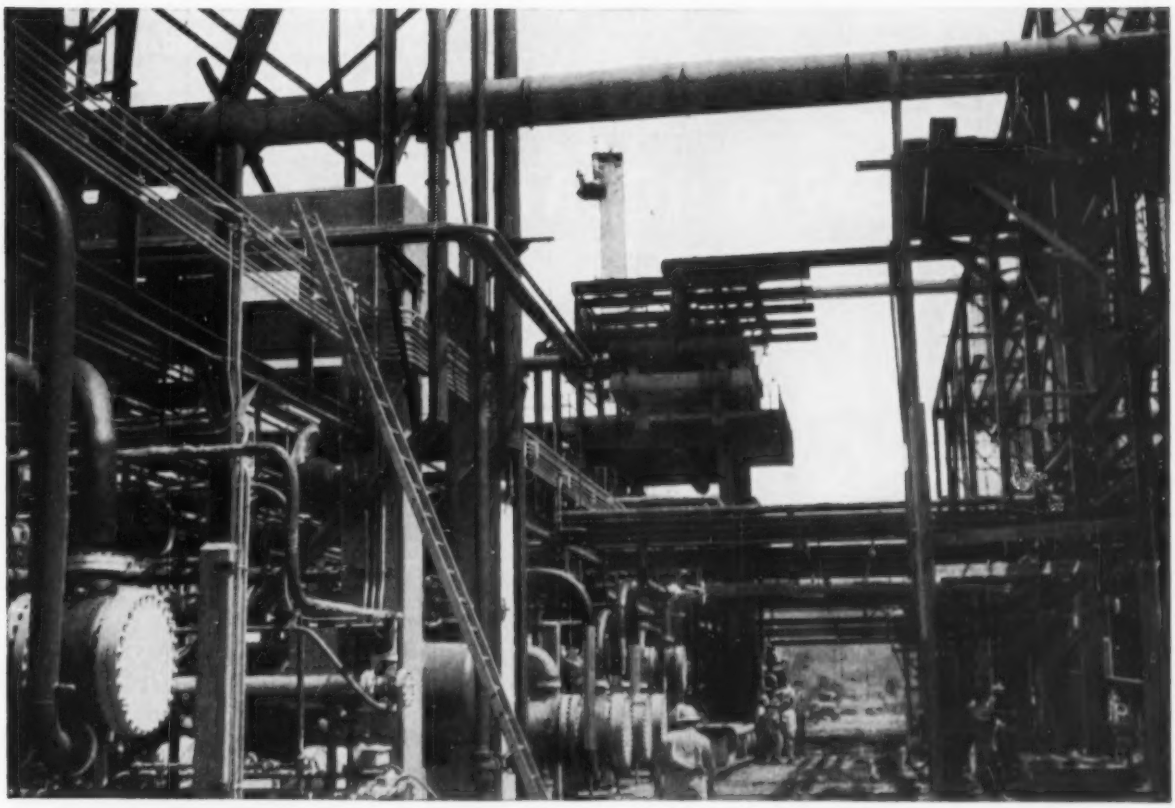
Rigid electrical inspection can do much to insure proper and safe installation of equipment and materials with savings in time and money. Proper inspection will reduce hazards, safeguarding life and property.

Two important, intangible relationships develop as construction progresses with the contractor and with the resident engineer.

It is of utmost importance that all contact with the contractor be on a professional basis; that he be required to meet all specifications and make

* WPRA, Houston.

For more data on advertised products, use Readers' Service Cards, last page.



Over 200,000 Sq. Ft. of Tube Surface for Commonwealth at Ponce, P. R.

In 1955 Lummus designed and built all of the heat exchangers for Commonwealth Refining Company's complete new refinery at Ponce, Puerto Rico. Well over 100,000 sq. ft. of tube surface is represented in exchangers for the atmospheric and vacuum distillation unit, Houdriflow fractionation and vapor recovery sections, Houdriformer, sulfuric acid alkylation and acid regenerating units, and catalytic polymerization unit.

Before the original refinery was placed in operation, Lummus was requested to increase the refining capacity by approximately 150%. The new addition is scheduled for completion by the end of 1956. Repeat orders on Lummus designed equipment are frequent, because Lummus heat exchangers are engineered to meet customer requirements for long and trouble-free service.

The Lummus Company has now established a standard line of heat exchange equipment to meet the requirements of TEMA Class "R" and API-ASME code requirements. Write for your free copy of Bulletin MD-164 which completely describes this equipment.

THE LUMMUS COMPANY, Heat Exchanger Division, 385 Madison Avenue, New York 17, N. Y.
Atlanta • Boston • Chicago • Cincinnati • Cleveland
Dallas • Denver • Detroit • East Chicago (Indiana)
Houston • Kalamazoo • Kansas City • Los Angeles
Minneapolis • Nashville • New Orleans • Newton (Iowa) • Niskayuna (New York) • Omaha • Pittsburgh
Salt Lake City • San Francisco • Springfield (Mass.)
Syracuse • Toledo • Wayne (Pa.) • Athens • Buenos Aires • Caracas • The Hague • Lima • London • Mexico City • Montreal • Paris • Rome • San Juan

Fabricated Piping Division Plant at East Chicago, Ind.

Steam Surface Condensers • Evaporators • Extraction Bleeder Heaters • Steam Jet Air Ejectors • Steam Jet Refrigeration • Barometric Condensers • Heat Exchangers for Process and Industrial Use • Process Condensers • Pipe Line Coolers.

LUMMUS

THE LUMMUS COMPANY, HEAT EXCHANGER DIVISION • 385 MADISON AVENUE, NEW YORK 17, N. Y.

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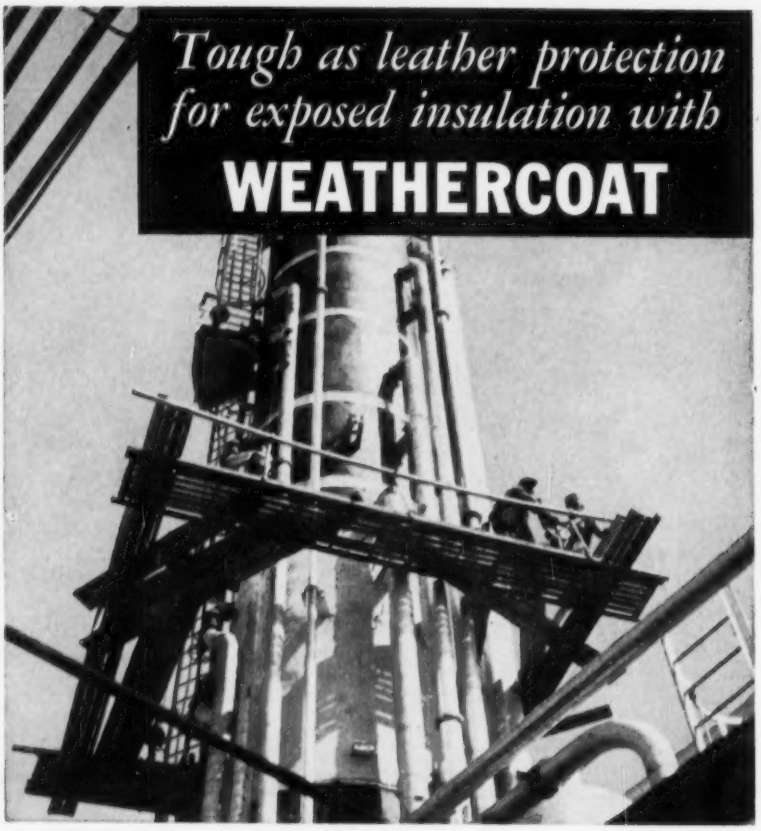


. . . the asphaltic coating that stays "ALIVE"

Thermal insulation on outdoor operating facilities needs a "raincoat." This material depends upon small air spaces formed by the flake fibers, or spheres of solids in the insulation itself to retard the flow of heat (or cold). Should moisture fill all or part of these air spaces the efficiency of the insulation would be seriously affected.

Weathercoat gives lasting protection. Weathercoat has an extremely high resistance to moisture in all its forms. (It has a Perm rating of 0.0175 for 0.10" thick dry film.) It is a factory compound of asphalt emulsion and mineral fillers and fibers that sets to a smooth, tough and pliable finish. Because no clays or other hydrophilic fillers are used in Weathercoat, it stays "alive." This assures long-lasting protection for insulated surfaces.

Nation-wide acceptance. Many of the largest refineries, chemical plants, and power stations in the nation are regular users of Weathercoat, both for maintenance and for new construction. During the last year alone, over 5 million sq. ft. of insulation have been coated with Weathercoat. The Laykold Engineer in our office nearest you will supply full details.

AMERICAN Bitumuls & Asphalt COMPANY

200 BUSH ST. • SAN FRANCISCO 20, CALIFORNIA

E. Providence 14, R.I. Perth Amboy, N.J.
Baltimore 3, Md. Mobile, Ala.
Cincinnati 38, Ohio Columbus 15, Ohio
Tucson, Ariz. Seattle, Wash.
Baton Rouge 2, La. St. Louis 17, Mo.
Inglewood, Calif. Oakland 1, Calif.
Portland 7, Ore. Washington 5, D.C.
San Juan 23, P.R.

Heard at Meetings . . .

all installations in a workmanlike manner, yet be dealt with on a fair and friendly basis.

Upon completion of a particular test, the resident engineer should be notified in writing as to the results of each test with any deficiencies noted. The contractor is furnished a copy of the report, which he can use as a check-off list. This makes it easier for the contractor to schedule work.

Hardly too much emphasis can be placed on the need for proper coordination between construction and operating forces where construction continues in an operating area. One moment's carelessness can result in disastrous accidents and loss of property. The electrical inspector can be of tremendous value in situations of this nature. (N. C. Casdorph and J. H. Wieting, Carbide & Carbon Chemicals Company.)

In The Future . . .

University of Oklahoma Extension Study Center will be the scene of the 1956 Annual Corrosion Control Short Course April 3-5.

The committee of the Central Oklahoma Chapter of the National Association of Corrosion Engineers, in cooperation with the University of Oklahoma, is planning the program. Corrosion engineers, corrosion control supervisors, field men, and foremen should benefit from the program.

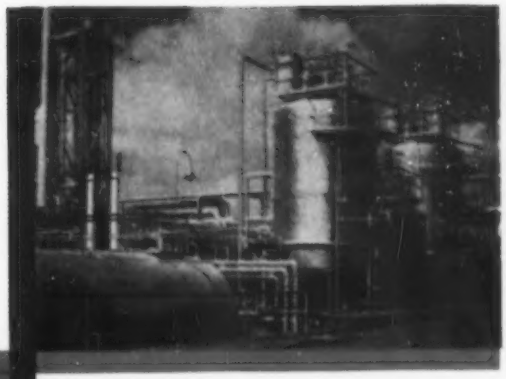
Fourth annual one-day meeting of the "Experience in Industry" series, sponsored jointly by the Philadelphia-Wilmington Section of the American Institute of Chemical Engineers and the University of Pennsylvania, will be held on April 17 at Museum Auditorium on the Penn Campus in Philadelphia.

This year's topic will be "Economic Practices in the Chemical and Petroleum Industries." The program has been developed specially as a unique educational opportunity of special interest to engineers who have been working in industry for five to ten years and to senior and graduate chemical engineering students.

Speakers are being drawn from industry to cover those phases of current industrial economic practices which are of general importance, in-

For more data on advertised products, use Readers' Service Cards, last page.

IF YOU CAUSTIC WASH, ACID TREAT, DOCTOR TREAT OR SWEETEN....



PETRECO

EQUIPMENT WILL HELP YOU DO IT BETTER

Petreco Electrofining permits the precision-controlled, continuous contacting of light hydrocarbons with a treating agent, then rapidly separates the chemical from the product. Electrofining delivers a finished product, from tower to market, with a brief treating period and negligible settling time.

PETRECO ELECTROFINING FOR DISTILLATE TREATING

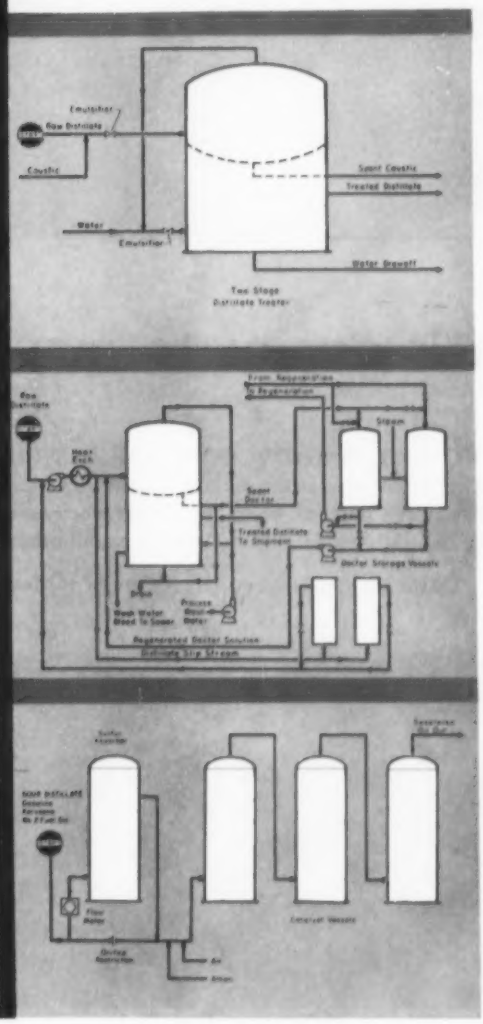
Petreco Electrofining, as applied to caustic washing or acid treating, or combinations of these with water washing, has rendered conventional processing obsolescent. Compared with the large ground areas and multiple vessels of old-fashioned treating plants, Electrofining equipment does the job in a small space with one or two small vessels, and much less piping, fewer pumps, and, since it operates continuously and automatically, less operating attention.

ELECTROFINING — DOCTOR TREATING

In the Petreco Electrofining-Doctor Treating, the doctor solution is continuously dispersed into the gasoline stream treated. The volume of doctor solution, degree of dispersion and contacting time are precisely controlled by automatic instrumentation. The powerful Petreco electric field coalesces the dispersed phase of mixture resulting from the doctor solution injection and separates the spent doctor solution from the gasoline. "Blackstrap" is removed continuously, resulting in more efficient spent doctor regeneration.

PETRECO-BENDER SWEETENING

The Bender Process sweetens gasoline, kerosine, jet fuel and No. 2 fuel. It is especially effective in the kerosine No. 2 fuel range. Sweetening is effected by converting mercaptans to disulphide by oxidation. There is no product loss in Bender Processing and chemical costs are around .5 cents per barrel. To attain treatment, sulphur is added to the distillate, plus a small amount of alkali, plus air. This mixture is passed over a bed of solid catalyst, yielding a sweet, bright, non-corrosive product.



PETRECO *A DIVISION OF PETROLITE CORPORATION*

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1390 East Burnett Street, Long Beach 7, California

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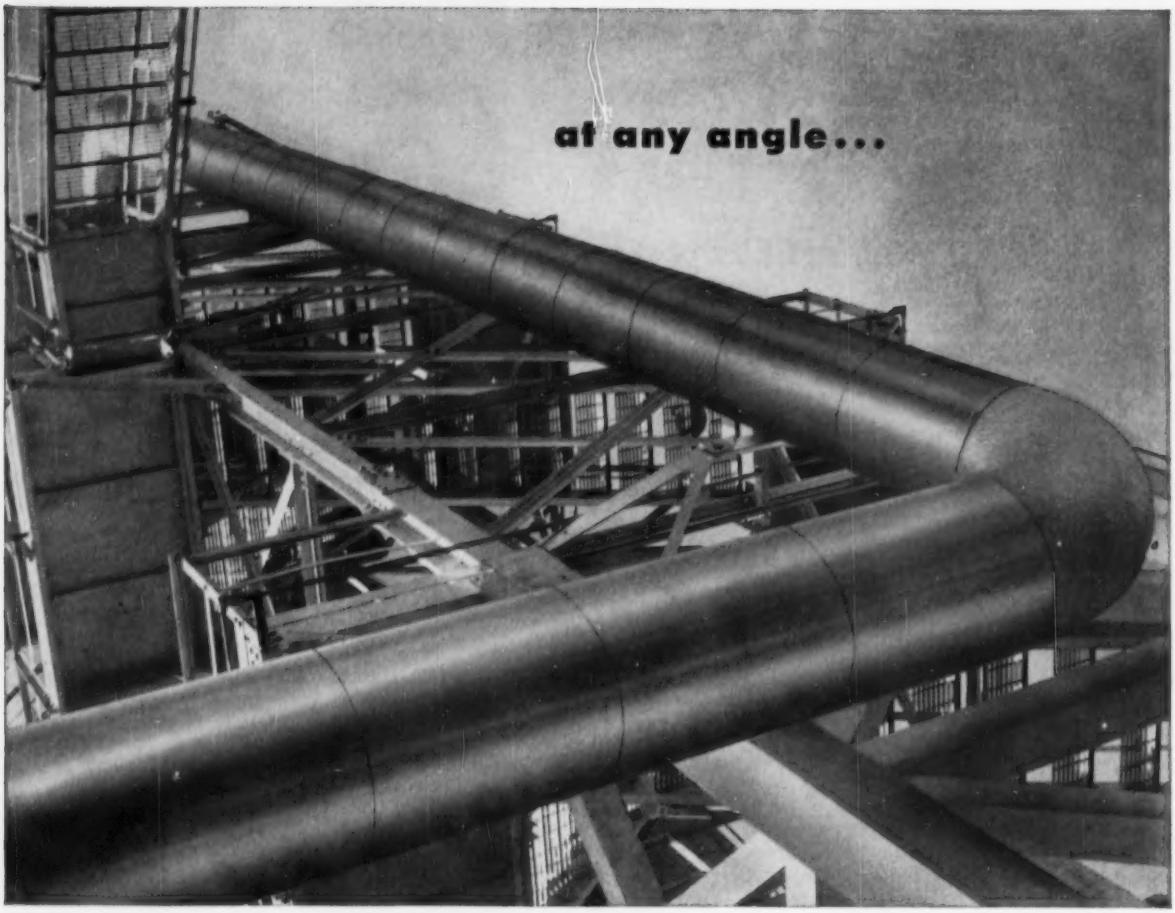
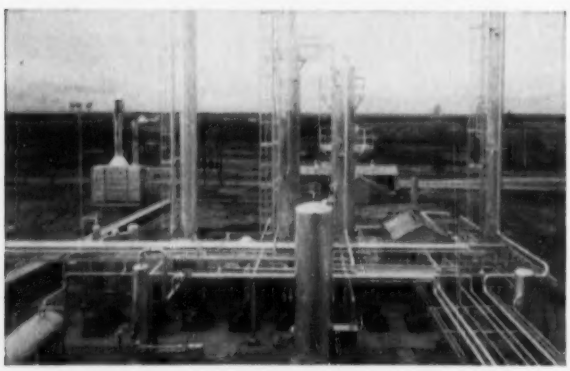


it's easier to insulate pipe with Unibestos®

NO MATTER HOW COMPLEX THE PIPELINE, Unibestos insulation makes installation simpler. It's easily cut, mitered, or grooved for effective insulation of bends, expansion joints, ells, tees and other fittings.

Unibestos' unique construction provides greater protection against heat loss—even at the difficult joints—than other nonfibrous insulation. Amosite, the African long-fiber asbestos, gives Unibestos the extra strength to resist shock and vibration. And Unibestos has excellent chemical stability...withstands moisture, steam, acid or chemical fumes.



STANDARD PRODUCTION SIZES

Unibestos Pipe Insulation is regularly made in 3-foot lengths for pipe sizes from ½″ through 24″, in standard thicknesses through 5″. Unibestos Block Insulation is made in 6″, 12″, 18″ or 36″ widths and in thicknesses from 1″ through 3″ in ½″ increments.

For complete information, write for descriptive Bulletin 109C

UNARCO®

UNION ASBESTOS & RUBBER COMPANY

1111 West Perry Street • Bloomington, Illinois

Heard at Meetings . . .

cluding the topics: Accounting Practices in Industry; Plant Investment; Cost of Services; Plant Operating Costs; The Effect of Product Price on Market Penetration; Economic Analysis, and Financing the Plant.

University of California Extension, through its division in the Department of Engineering, will hold a Conference on Marine Corrosion and Fouling Problems April 18-20 on the La Jolla campus.

The latest developments and thoughts of marine corrosion problems will be presented in a series of papers by recognized authorities. A forum discussion of measures for protection against biological, physical and chemical deterioration of wood, metal and concrete structures in a marine environment will be held.

Major topics will be "Introduction to the Study of Deterioration," "Fundamental Causes of Deterioration," "Deterioration Investigation," and "Deterioration Mitigation Procedures."

The conference will appeal to engineers concerned with all kinds of structures exposed to marine environment. The National Association of Corrosion Engineers is cooperating with the university on this conference.

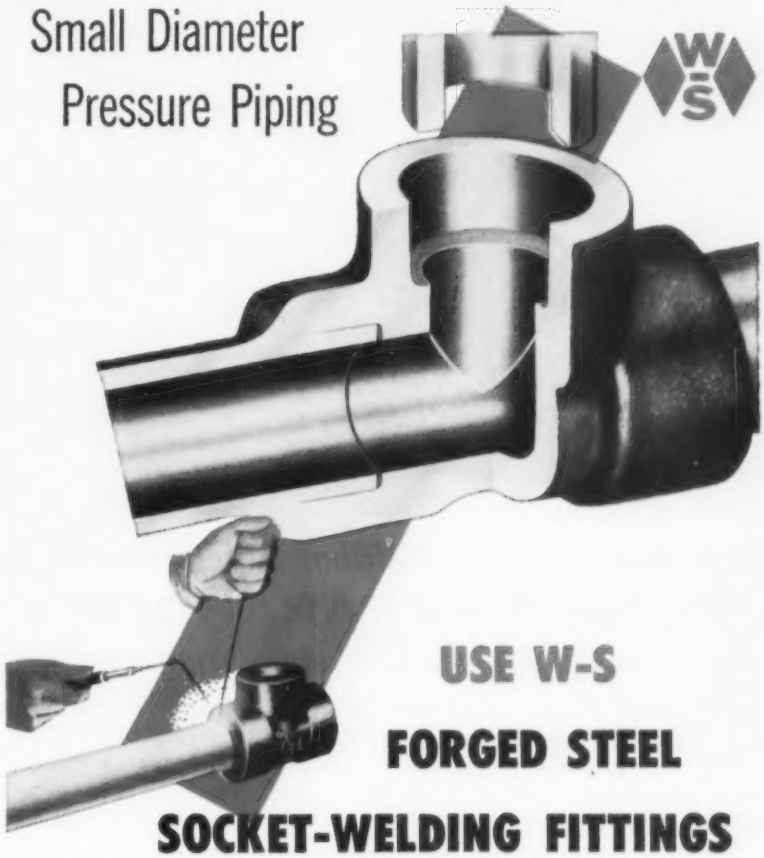
MEETINGS CALENDAR

MAR.	
19–21	Mid-West Gas Association, Hotel Fontenelle, Omaha, Neb.
19–21	Western Petroleum Refiners Association (Annual Meeting), Plaza Hotel, San Antonio, Texas.
21–23	Annual American Power Conference, Sponsored by Illinois Institute of Technology, Hotel Sherman, Chicago.
APRIL	
2– 3	Petroleum Engineering Conference, Sponsored by the University of Kansas, Lawrence, Kansas.
2– 4	American Institute of Electrical Engineers (Southwest District 7), Dallas, Texas.
3– 5	Annual Corrosion Control Short Course, University of Oklahoma, Norman, Okla.
4– 6	American Gas Association, General Management Conference, Conrad Hilton Hotel, Chicago.
4– 6	American Society of Lubrication Engineers, William Penn Hotel, Pittsburgh, Pennsylvania.
8–11	American Chemical Society (National Meeting), Dallas, Texas
11–13	Natural Gasoline Association of America (Annual Convention), Texas Hotel, Fort Worth, Texas.
14–18	Petroleum Equipment Suppliers Association, Annual Meeting, Boca Raton Hotel, Boca Raton, Fla.
17–19	Southwestern Gas Measurement Short Course, University of Oklahoma, Norman, Oklahoma.
18–20	National Petroleum Association (Semi-Annual Meeting), Cleveland Hotel, Cleveland, Ohio.

Continued on Page 253

Here's the **EASY WAY TO WELD**

Small Diameter Pressure Piping



USE W-S FORGED STEEL SOCKET-WELDING FITTINGS

In addition to providing high strength and toughness, W-S Forged Steel Socket-Welding Fittings are also easy to install. Deep sockets support and align the pipe for welding . . . eliminating the need for tack welding or special fixtures. No back-up ring is needed either. The fillet-weld is completely outside the pipe. Welding icicles just can't form inside the pipe. The result is a clean, tight welded joint that will readily resist high pressures and the stresses of shock and vibration. What's more, installation costs are lower.

W-S Socket-Welding Fittings are available in sizes ⅛" to 4" for schedule 40, 80, 160 and double-extra heavy pipe in carbon steel, stainless steels and alloy steels.

For complete information on the installation and operation advantages of W-S Forged Steel Socket-Welding Fittings, send today for Bulletin A-3-56.

W-S FITTINGS DIVISION

H. K. PORTER COMPANY, INC.
Roselle, New Jersey

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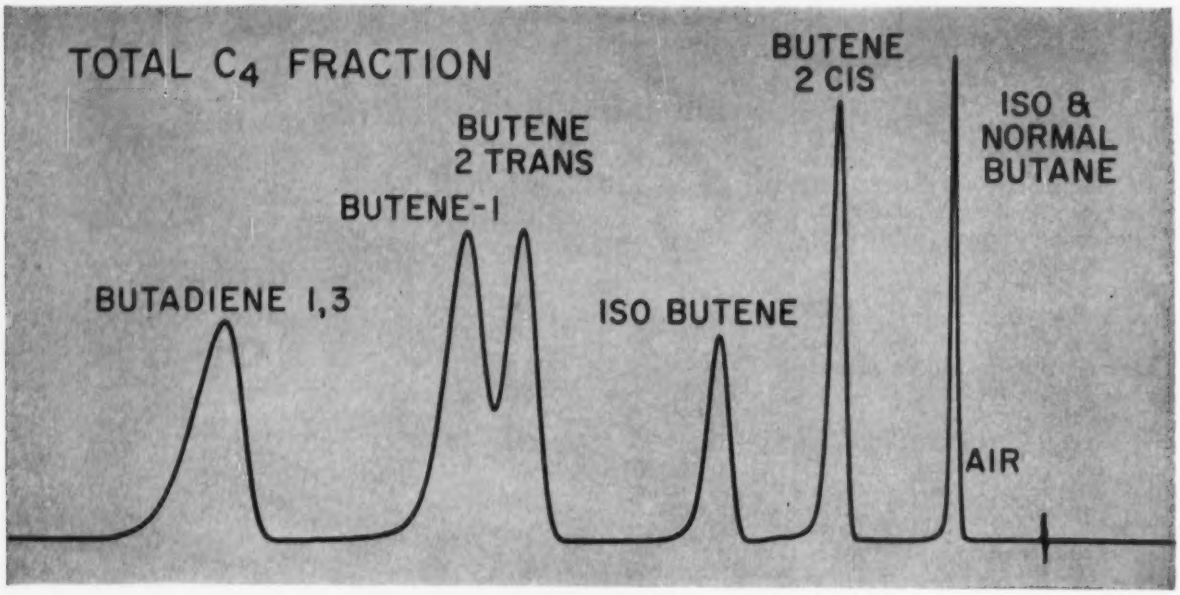


New P-E Model 154 Vapor Fractometer gives you

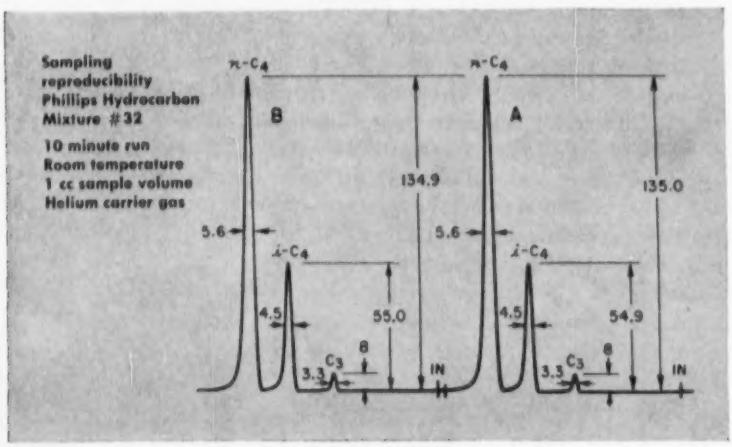
BUTENE SEPARATION IN 15 MINUTES!

Analysis extremely difficult by ordinary methods

Employing the principles of gas chromatography, P-E's new Model 154 Vapor Fractometer is a revolutionary advance in the field of gas and volatile-liquid analysis. Quantitatively it is fast, precise, uncomplicated to operate, extremely simple in calculation, and above all, many times less expensive than distillation columns, mass spectrometer, or any other instrument for the purpose. Qualitatively the instrument gives extremely clean separations – even of components and isomers which cannot be separated by ordinary methods.

The butene separation shown above demonstrates the instrument's ability to take advantage of the physical properties of the sample (in this instance, the chemical complexing with the stationary phase) to achieve the desired separation. Other column materials will readily resolve the paraffin hydrocarbons.

Vapor fractometry is the fastest, simplest, most inexpensive method of analysis in existence today.



The remarkable reproducibility of the Vapor Fractometer is shown in the two runs, A and B. Note that the quantitative values of A, B, and the Phillips analysis agree to small fractions of a percent.

MOLE % CONCENTRATION

	Run A	Run B	Phillips
Propane	2.56	2.56	2.55
Isobutane	24.00	24.05	23.98
N-butane	73.44	73.39	73.47

This is the Model 154 Vapor Fractometer – price, $2200.00 including recorder. Send for descriptive bulletin.

Perkin-Elmer
CORPORATION
Norwalk, Connecticut

MEETINGS, continued

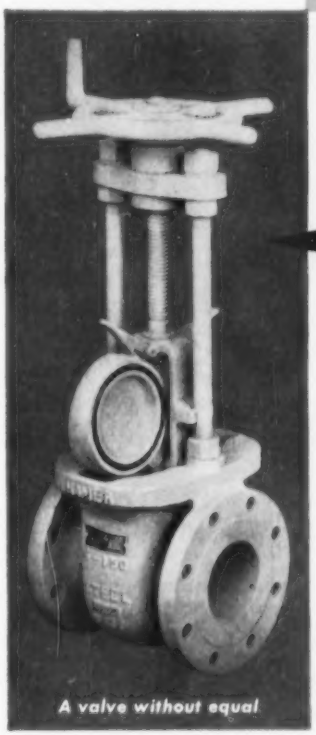
APRIL	
18–20	Conference on Marine Corrosion and Fouling Problems, University of California, La Jolla campus.
23–25	American Oil Chemists Society, Annual Spring Meeting, Shamrock-Hilton Hotel, Houston.
23–25	Chemical Progress Week.
25	Association of Consulting Chemists and Chemical Engineers (Symposium), Belmont Plaza, New York.
25	Instrument Society of America, Wilmington Section, Hotel du Pont, Wilmington, Delaware.
25–29	World Oil Exposition, Houston.
26–27	American Institute of Electrical Engineers (National Meeting), Bradford Hotel, Boston.
27	Society of Chemical Industry, Chemical Industry Medal Presentation, Waldorf-Astoria Hotel, New York.
MAY	
1	Independent Petroleum Association of America, (Semi-annual Meeting), Statler Hotel, Los Angeles.
1	American Petroleum Institute (Safety and Fire Prevention Annual Mid-Year Meeting), Warwick Hotel, Philadelphia.
1	Annual Conference for Engineers, The Ohio State University, Ohio Union, Columbus.
6– 9	Liquefied Petroleum Gas Association (Convention and Trade Show), Conrad Hilton Hotel, Chicago.
6– 9	American Institute of Chemical Engineers, Roosevelt Hotel, New Orleans.
7–11	American Welding Society (Spring Meeting), Hotel Statler, Buffalo, N.Y.
11–12	76th Annual Convention of the Michigan Engineering Society, Pantlind Hotel, Grand Rapids.
14–16	Petroleum Electric Power Association (Annual Convention), Hotel Robert Driscoll, Corpus Christi, Texas.
14–17	American Petroleum Institute, Division of Refining (Mid-Year Meeting), Sheraton-Mount Royal Hotel, Montreal, Canada.
14–17	Design Engineering Show, Convention Hall, Philadelphia.
15–17	Industrial Waste Conference, Purdue University, Lafayette, Ind.
16–18	American Chemical Society, Division of Rubber Chemistry (Annual Meeting), Hotel Cleveland, Cleveland.
16–18	American Gas Association, (Chemical Engineering and Manufactured Gas Production Conference), Benjamin Franklin Hotel, Philadelphia.
24–25	Natural Gas and Petroleum Association of Canada, Sheraton-Brock Hotel, Niagara Falls, Ont.
28–30	Chemical Institute of Canada (Annual Conference and Exhibition), Mount Royal Hotel, Montreal, Quebec.
30–June 1,	Short Course on Gas Technology, Sponsored by Texas A&M College, Kingsville, Texas.
JUNE	
3– 8	Society of Automotive Engineers (Summer Meeting), Chalfonte-Haddon Hall, Atlantic City, N.J.
4– 8	National Fire Prevention Association, (Annual Meeting) Statler Hotel, Boston, Mass.
7– 9	Manufacturing Chemists' Association (Annual Convention), Greenbrier Hotel, White Sulfur Springs, N.Y.
11–15	Technical Conference on Plastics, Sponsored by The Society of the Plastics Industry, Inc., Coliseum, New York.
17–22	World Power Conference, Vienna, Austria.
17–22	American Society for Testing Materials (Annual Meeting and Apparatus Exhibit), Chalfonte-Haddon Hall, Atlantic City, N.J.
18–20	American Society of Heating and Air-Conditioning Engineers, Shoreham Hotel, Washington, D.C.
21–22	Western Petroleum Refiners Association, Regional Technical-Industrial Relations Meeting, Broadview Hotel, Wichita, Kans.
25–29	American Institute of Electrical Engineers (Summer and Pacific General Meeting), San Francisco.

Send for FREE Bulletin ▸▸▸

HAMER VALVES, INC.
Box 1851, Long Beach 1, California

Please send immediately a copy of your new Visible Wedge Bulletin.

Name_____
Company_____
Address_____
City_____ State_____ 5



A valve without equal

New SURE-SEAL SHUT-OFF

Combining precision metal-to-metal fit of wedge and seats augmented by dependable seal rings, the new Visible Wedge provides the impenetrable sealing action of a Line Blind, yet maintains the simplicity of operation found in a gate valve.

The new Hamer Visible Wedge is available in Straightway, Tee, and Ell styles meeting all A.S.A. specifications.

New Hamer VISIBLE WEDGE

The finest positive sealing valve ever developed

New STABILITY

Hamer Visible Wedge Valves are absolutely rigid. No line movement necessary to open or close valve.

New SIMPLICITY

"Full-view" wedge. One glance determines whether line is full open or full close.

New SAFETY

Operator has complete control of the wedge at all times. Wedge pivots—no hand lifting necessary.

Hamer VALVES, INC.

2919 Gardenia Ave., Long Beach 6, California
Representatives Throughout the World.

For more data on advertised products, use Readers' Service Cards, last page.

FLEXITALLIC WITH A CAPITAL "F"

The capital "F" in Flexitallic is for your protection. It designates the original Spiral-Wound Gasket made exclusively by this Company since 1912.

It represents the storehouse of gasket design experience used by Flexitallic engineers in providing exactly the right seal for your high-pressure, high-temperature sealing problem.

Designers and engineers responsible for confining fluids in extreme or hazardous service look to Flexitallic Gaskets for the high safety factor so essential in their calculations. It's why the capital "F" is so important in gasket specifications.

Each Flexitallic Gasket is designed and engineered to meet specific conditions of thermal and physical shock, corrosion, vibration, weaving and unpredictable joint stresses. Spirally-wound V-crimped plies of required metal with alternating plies of proper filler result in a resilient gasket having characteristics of a calibrated spring.

Flexitallic Gaskets are at highest efficiency when bolted up cold at a predetermined load. For all pressure/temperature ranges from vacuum to 10,000 lbs., from extreme sub-zero to 2000°F. For all standard joint assemblies. In four thicknesses for special requirements: .125", .175", .250", .285".

FLEXITALLIC GASKET CO.
8th & Bailey Sts., Camden 1, N.J.
Representatives in principal cities

Flexitallic®
SPIRAL-WOUND GASKETS

FOR PIPE FLANGES, PRESSURE VESSELS AND PROCESS EQUIPMENT

TEFLON FOR PROCESS APPLICATIONS

The ideal seal for many process applications is a Flexitallic Gasket with Teflon trapped between edges of stainless steel. Ask for folder, "Teflon in Flexitallic Gaskets."

*Flexitallic is a registered trade name. No one else can make a Flexitallic Gasket. Look for *Flexitallic Blue*—it's our exclusive blue-dyed Canadian asbestos filler.

For more data on advertised products, use Readers' Service Cards, last page.

Who's Building . . .

Next Construction Boxscore will appear in the April issue.

French Set Petrochemical Expansion

NAPHTACHIMIE, French petrochemical concern rapidly proceeding toward full recovery from the devastation of World War II, is planning a major expansion of its ethylene-oxide plant at Lavera.

The expanded plant will have a capacity nearly double its present 8000-ton-a-year output. Total investment in the facilities at Lavera will exceed $30 million, making it the largest project of its kind on the continent.

Design and engineering for the project will be handled by Scientific Design Company, Inc., a New York firm. The work will be completed in 1957.

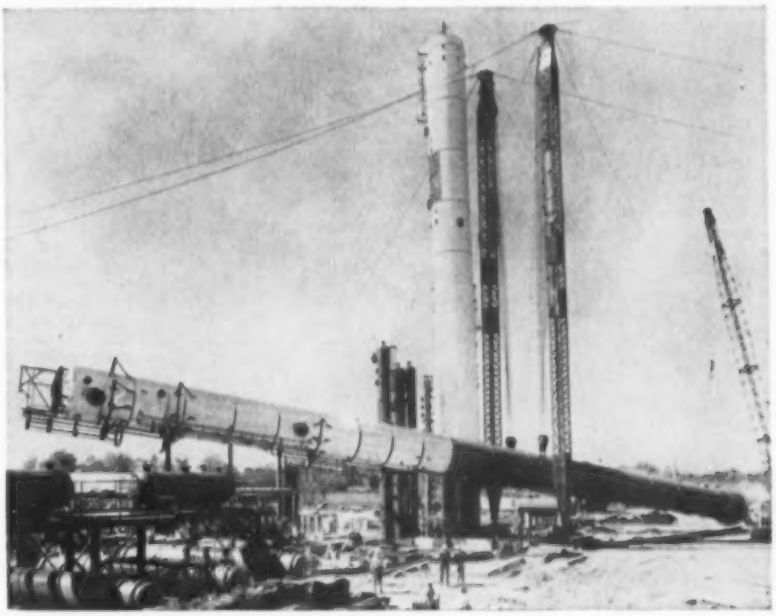
The fundamental idea for the process used at Lavera originated in France more than 20 years ago. The first commercial application of direct oxidation of ethylene took place in the U. S., however, and since then Scientific Design has developed its own version of the process.

The process was returned to France in 1953 with construction of the original Lavera plant.

The only other European producer of ethylene by direct oxidation will be Societe Chimique des Derives du Petroles, which is building a plant at Antwerp. The Belgian company is putting up an $8-million plant.

Expansion of the facilities at Lavera follows a rapid increase in French demand for ethylene oxide and glycol compounds. Due in part to the increase in the use of automobiles in France, the market has expanded some 30 percent over the past two years.

In addition, there has been an increased market for glycol ethers and similar products used in the paint and resin industries. This is brought about by a boost in new home construction and a greater emphasis on home maintenance.



Here's One of the Biggest—

One of the largest fractionating columns ever built goes up at American Cyanamid Company's new mono-methylstyrene plant near Avondale, La. The tower, 186 feet tall, was fabricated by Delta Tank Manufacturing Company at Baton Rouge, La., and shipped to Avondale on a string of four railway flat cars. It weighs 293,000 pounds and is twice the height of standard fractionating columns.

Stress relieving was done at Baton Rouge in three heats, with the first third of the tower moved into place aboard the flat cars on which it was built and the ends of the 75-foot-long furnace bricked up around it. After treatment at 1300 F., the brick walls were knocked out, the next section of the column moved into the chamber.

Dow Expansion in Texas Due to Cost $45 Million

THE DOW CHEMICAL COMPANY, planning to spend at least $75 million on new construction in 1955, has scheduled a $45-million expansion of its facilities at Freeport, Texas. Another $20 million will be spent for a new plant at Baton Rouge, La.

In addition to the projects in Texas and Louisiana, Dow plans to build a synthetic-latex plant at Pittsburg, Calif. The company's building program this year represents a 50-percent increase over the $50 million it spent for expansion in 1955.

Cost of the California plant will run in excess of $1 million. To be the company's fourth latex plant, it will produce a wide range of styrene-butadiene latexes. Similar Dow plants are in operation at Midland, Mich; Sarnia, Ontario, and Freeport.

The Louisiana development will include plants for the production of several organic chemicals. No details were available on what the project would involve.

New petrochemical plants to be built in the Texas division will produce acetylene, methylacetylene, ethanolamines, synthetic glycerine and soil fumigants.

Among the plants to be expanded at Freeport are those producing butadiene, chlorine, ethylene oxide, methyl chloroform, glycerine, glycol, perchlorethylene and styrene.

This will be the first time Dow has

produced acetylene or methylacetylene, and the first time ethanolamines and soil fumigants have been produced in the Texas division.

The new glycerine plant will be the second of its kind at Freeport. The first, which will be expanded, began operations in 1955, with a rated capacity of 36 million pounds a year.

The ethylene-oxide project will increase Dow's capacity to produce this material by 30 million pounds a year. This phase of the program will be completed late in 1956.

In addition to the production expansion, Dow's Freeport program calls for construction of a division administration center, new pilot plants and laboratory facilities and a 29-mile pipe line. Also planned are expansions of the anti-freeze canning plant and the W. R. Veazey Research Center, as well as replacements in the powerhouse.

Construction on some of the projects is underway, and work on the others will be started during the year. The last project in the program will be completed in the first half of 1958.

During 1955, Dow brought in new plants for the production of glycerine and polyethylene, and expanded its capacity to make ethylene, glycol and polystyrene.

Continental Oil Company has completed a $450,000 dairy-wax plant at its Ponca City, Okla., refinery. The new installation, with a capacity of 11 million pounds a year, will boost Conoco's annual output to 20 million pounds.

Venezuelan Gulf Refining Company expects to complete new installations at its 50,000-barrel-a-day refinery near Puerto La Cruz by the end of 1956. A catalytic cracker and visbreaker are being installed by Companhia Kellogg de Venezuela. Total cost of the project will run between $8 and $9 million.

Standard Oil Company of Texas will expand its El Paso, Texas, refinery, increasing capacity from 36,000 barrels a day to 61,000 barrels. No details were available. The company is a Standard Oil Company of California subsidiary.

The British American Oil Company, Ltd., has reached the final stages of construction on a catalytic-reforming unit at its Montreal East, Queb., refinery. Meanwhile, the company is planning construction of another new catalytic reformer at its Clarkson, Ont., refinery.

The Montreal unit, capable of processing 13,000 barrels a day of naphtha, was licensed by The Atlantic Refining Company. The Lummus Company of Canada, Ltd., handled engineering and construction for the project, a $3-million job.

At Clarkson, the company will build a $4-million reformer. Using a platinum catalyst, the new unit will process about 10,000 barrels a day of straight-run naphtha. This unit, also to be built by Lummus, is scheduled for completion early in 1957.

The Clarkson reformer will be the third to be built by British American in the past two years. A unit similar to the reformer at Montreal was added to the refinery in Calgary, Alta., in 1955.

An $8-million catalytic-cracking unit was added to the Clarkson refinery in 1954. Present daily thruput of that refinery is 21,500 barrels.

In the Northwest . . .

Texaco Plans New Refinery

The Texas Company, long considering a refinery in the Pacific Northwest, is negotiating for purchase of a site at Anacortes, Wash. Meanwhile, two other companies also are planning Washington-State refineries.

Straits Refining Company, a Dallas, Texas, concern, has been issued a fast tax write-off certificate for construction of an 8000-barrel-a-day refinery in the Puget Sound area. And U. S. Oil & Refining Company has awarded the contract for construction of its proposed refinery at Tacoma.

The Texaco refinery would be adjoining Shell Oil Company's 50,000-barrel-a-day Anacortes refinery. Shell's was the second Washington refinery to go on stream in the past two years.

The first was General Petroleum Corporation's 35,000-barrel-a-day plant at Ferndale. Already the company has a $9 million expansion program scheduled for this refinery.

No decision has been made on the size of plant Texas will build at Anacortes, nor on the type processes to be used. Capacity of the new plant, however, is expected to be about 40,000 barrels a day.

Straits Refining, being organized by C. F. Tears, was approved for rapid amortization on more than $26 million. This is to cover construction of a plant to turn out some 8000 barrels a day of aviation gasoline and jet fuels.

The company received certificates for 100 percent on $14,100,000 for avgas facilities, plus 65 percent on $5,315,000, 45 percent on $6,690,000, and 15 percent on $325,000.

The contract for engineering and construction of the first process units of the U. S. Oil & Refining plant at Tacoma went to J. B. Gill Company. The units, due to go on stream by summer, 1957, will include a combination topping and thermal-cracking unit and a Universal Oil Products Company catalytic-polymerization unit.

Engineering has not been completed, but the plant is expected to have an initial capacity of about 6500 barrels a day. This later will be increased to around 25,000 barrels.

At Ferndale, General Petroleum will add a second Sovaformer and a distillate-treating unit to its new refinery. The work, to be completed in 1957, is part of a $9 million expansion program for the refinery.

The reformer will have a daily capacity of 9000 barrels. The present reformer is a 6000-barrel-a-day unit. The other new unit will treat light straight run gasoline and naphtha.

Another company considering a refinery in Washington is Standard Oil Company of California. The company has a 2000-acre site for a refinery near Seattle.

Shell Oil Company has gone on stream with a new fluid catalytic-cracking unit at its recently-completed Anacortes, Wash., refinery. The unit, designed for a daily intake of 23,000 barrels, employs a new technique expected to reach a greater high-octane-gasoline yield than is possible with more conventional cracking plants.

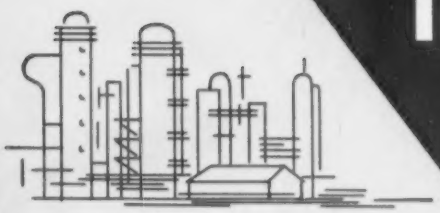
The technique is the result of Shell development work. The company will release specific performance data and information on the unit during the spring of 1956. At that time, the design will be

Tide Water Speeds Construction—

This Orthoflow fluid catalytic-cracking unit is one of the major installations being built at Tide Water Associated Oil Company's new 130,000-barrel-a-day refinery under construction near Wilmington, Del. The main column, to tower 250 feet, will convert 102,000 barrels-a-day of heavy crude into gasoline and other products. The guy derricks, 245-feet-high, are used to hoist the prefabricated sections of the unit into place.

Finest

IN THE FIELD



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"Cold weather reminds me of what Pritchard did at Tioga!"

"What has Pritchard got to do with the weather? And where or what is Tioga?"

"Pritchard had plenty to do with the weather! You mean I've never told you about Tioga?"

"No, you haven't. What is it?"

"Tioga is a place in North Dakota where Signal Oil and Gas Company has its new natural gasoline plant. Now, that's where Pritchard really went to work! They designed and engineered the whole plant. They sure had a tough weather problem to whip!"

"Was it bad?"

"Bad? I'll say so! Down to minus 40 degrees or less in the winter and then up to 110 in the summer. You know how they solved it?"

"How?"

"Dry distillation! They didn't use a bit of steam in the gasoline recovery process. Imagine, gasoline recovery without using any steam. You know, I'm not too surprised."

"What makes you say that?"

"I know Pritchard. They cut their eye teeth on problems like Tioga."

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"Cold weather reminds me of what Pritchard did at Tioga!"

Dry Distillation Features Signal's Tioga Plant— Designed and Engineered by Pritchard

Signal Oil and Gas Company's new Tioga, North Dakota natural gasoline plant features dry distillation, with no steam used in the gasoline recovery process.

The entire plant was designed and engineered by Pritchard.

This plant was designed for extremely cold weather operations, with temperatures —40° F. or below in the winter; up to 110° F. in the summer.

Just another in the long parade of successful installations, the Signal plant is further proof that Pritchard designers and engineers have the skill to design facilities for you.

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Who's Building . . .

made available to other refiners through licensing arrangements.

Initial operation of the Anacortes refinery began in September 1955, with startup of the crude-distillation and catalytic-reforming units. The refinery was designed to process 50,000 barrels a day.

The British Petroleum Company, Ltd., will spend about $55 million for expansion of its Kent refinery. On the Isle of Grain, near London, the refinery now processes some 90,000 barrels a day.

The new expansion, consisting of additional distillation equipment and other processing plants, will raise this figure to about 140,000 barrels. The program, to be completed late in 1957, will be in addition to a 2600-barrel-a-day aviation gasoline plant to be built at Kent at a cost of $18 million.

Arabian American Oil Company, which recently completed a fluid Hydroformer at its Ras Tanura refinery in Saudi Arabia, now is adding a 15,000-barrel-a-day Hydrofiner. The unit, expected to cost about $4.1 million, is being installed by The Lummus Company. It is scheduled for completion during the spring of 1957. Lummus also built the Hydroformer, a 12,500-barrel-a-day unit.

Union Oil Company of California will move its pilot-plant units from the refinery at Wilmington, Calif., to a new research center at Brea. The project will consolidate the company's research effort at Brea. Engineering and construction will be done by Ehrhart & Associates, Inc.

The Carter Oil Company, planning capital expenditures for 1956, has set aside $1 million to cover construction now underway at its Billings, Mont., refinery. Covered by the appropriation is a 6900-barrel-a-day Hydrofiner and a catalytic reformer with a daily capacity of 2500 barrels a day.

Imperial Oil, Ltd., will build a $38-million plant at Sarnia, Ont., for making detergent alkylate. To be completed in mid-1957, the plant will be the first of its kind in Canada and will mark Imperial's first step into the petrochemical field since its Chemical Products department was set up in 1955. A section of the plant will produce tripropylene and tetrapropylene.

Standard Oil Company of British Columbia, Ltd., has started operations with a 2750-barrel-a-day catalytic-reforming unit at its Vancouver, B. C., refinery. The new unit, which cost $2,500,000, is a Platformer licensed by Universal Oil Products Company.

ERRATUM

Cutlines for two pictures in "Who's Building" for February were reversed. The description of the plant shown on page 188 appeared with the picture on page 196. Lines with the picture on 196 should have accompanied the picture on 188.

On page 188, was shown an aerial view of new combination Platforming-Uniting units at The Texas Company refinery in Port Arthur, Texas. The picture on page 196 shows a gas-recovery plant The British Petroleum Company recently completed at Hamburg.

Monsanto Chemical Company has started construction on a plant at Luling, La., for the production of Adipic acid. At the Lion Oil Company's ammonia and ammonium-nitrate plant, the new installation will be the first integration of production since the two companies were merged in September 1955. The Monsanto plant is expected to be on stream early in 1957.

Polymer Corporation, Canada's government-owned synthetic-rubber concern, is planning to build a new butadiene plant in Alberta. The company's present butadiene facilities are at Sarnia, Ont.

Texas Butadiene & Chemical Corporation, building an alkylate-avgas and butane plant at Houston, will use an underground storage system in Chambers County, Texas, for handling butane and isobutane. Storage wells, each with minimum capacity of 100,000 to 200,000 barrels will be drilled in salt domes.

Standard Oil Company (Indiana) will build a four-unit lubricating-oil plant at its refinery in Casper, Wyo. Construction of the first three units will begin in May, with initial operations scheduled for May, 1957. Foster Wheeler Corporation will be general contractor. The four new units will include:

- A 4800-barrel-a-day vacuum pipe still.
- A 1000-barrel-a-day propane deasphalting plant.
- A 1500-barrel-a-day furfural extraction unit.
- A 2000-barrel-a-day dual-purpose MEK dewaxing and deoiling unit.

Anderson-Prichard Oil Corporation has started up a new catalytic-reforming unit at its Arkansas City, Kansas, refinery. The unit is designed to process 4000 barrels a day of low-octane naphthas into 98-leaded-octane reformate. A Platformer, the unit was designed, engineered and licensed by Universal Oil Products Company. Provision for future as a Rexformer was included in the design.

Petroleos Mexicanos is scheduling construction of a natural-gasoline plant in the State of Tabasco. The new installation, to be the government agency's second with a daily capacity of 300 Mmcf., will be completed in 1956.

It will be built by Hudson Enginering Company, which handled construction of a twin plant at Reynosa. The $7-million Reynosa plant went into operation late in 1955.

Kuwait Oil Company, Ltd., will increase capacity of its 30,000-barrel-a-day refinery at Mina Al Ahmadi, Kuwait, to 190,000 barrels a day. The new output will include increased production of middle distillates, marine diesel fuels and residual fuel oil.

Plans call for two 80,000-barrel-a-day atmospheric crude units and a gasoline-stabilization unit for each. The new structures will be erected on a site adjoining the company's existing refinery.

Work, to start early in the second quarter of 1956, will be completed late in 1957.

E. B. Badger and Sons, Ltd., the firm which built the present refinery, will design and procure the new units. Bechtel International Corporation, in association with George Wimpey and Company, Ltd.,

For more data on advertised products, use Readers' Service Cards, last page.

LESS DOWNTIME per year with AIRETOOL

An AIRETOOL tube maintenance program including regular use of AIRETOOL Tube Cleaners, Expanders and the Tube Expansion Control System, will keep your operation at peak efficiency and top production while reducing tube failure downtime to a minimum.

The hardest deposits are quickly removed from straight or curved tubes, quickly and thoroughly, with AIRETOOL'S powerful hi-speed cleaners that won't bog down. You roll tight, accurate tube joints with maximum bond when AIRETOOL Tube Expanders are used, while the unique AIRETOOL Tube Expansion Control System can cut time in half, when you overhaul or retube a bundle.

AIRETOOL 6000 SERIES CLEANER

Airetool ball bearing motor with single expansion cutter head. Motor is slip-fit constructed, has front and rear ball bearing thrusts. Cutter heads are precision made from special heat treated alloy steel, will quickly and thoroughly remove all foreign deposit from tubes. P-Type cleaner head shown is only one of many types available.

COLLINS 3-ROLL EXPANDER

Airetool Tube Expanders are made from finest alloy steel, expertly designed, precisely machined and heat treated for enduring service. Parallel rolling, self-feeding, they produce uniform expansion and tightness throughout the full thickness of the tube sheet. The G-100 5-roll expander is just one of many available for refinery use.

AIRETOOL TUBE EXPANSION CONTROL SYSTEM

The Airetool Tube Expansion Control System *automatically* and accurately rolls tube joints at production line speeds. Eliminates the danger of over or under expansion, fracture or distortion of tube sheet ligaments. Completely portable for field, shop or new work.

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There's an AIRETOOL Tube Cleaner and Tube Expander for every type of Tubular Construction.

Who's Building...

will engineer and construct the stills and auxiliary facilities.

The refinery is owned jointly by The British Petroleum Company, Ltd., and Gulf Oil Corporation.

Escambia Bay Chemical Corporation has started operations at its new nitrogen-fertilizer and ammonia plant at Pensacola, Fla. Planning further expansion into the petrochemical field, the company awarded the contract for construction of a polyvinyl-chloride resin plant at Pensacola.

Initial production of the ammonia plant ran 75 tons a day, and this will be the plant's 200-ton-a-day rated capacity. The plant, which also has started producing ammonium solutions, is a $25 million installation engineered and built by Chemical Construction Corporation.

Marking Escambia Bay's entrance into the resin field, the new polyvinyl-chloride resin plant will be built by Blaw-Knox Company. The installation, to be complete by late 1956, will have an annual capacity of 30 million pounds.

Wyandotte Chemicals Corporation will build a plant in Louisiana to produce ethylene oxide and ethylene glycol.

Petroleos Mexicanos has completed a $12-million expansion of its refining facilities at Minatitlan. Included in the project, which increased the refinery's daily output from 24,000 to 50,000 barrels, included a catalytic-cracking unit with a fresh feed capacity of 10,000 to 12,000 barrels a day and a total daily capacity of 15,000 barrels. Engineering was handled by The Fluor Corporation.

Frontier Refining Company has brought on stream two new refining units at its Cheyenne, Wyo., refinery. One is a 2500-barrel-a-day catalytic reformer and the other is a Unifiner with a daily capacity of 3000 barrels. The new units, both licensed by Universal Oil Products Company, are part of a $1.5-million program. They were installed by Procon, Inc.

Rohm & Haas Company is planning to build two new Houston plants, one for the manufacture of acetylene and the other for the production of ammonia and methanol. Gas from the ammonia plant will be used in the production of acrylate. This in turn will be used in an existing acrylate-monomers plant.

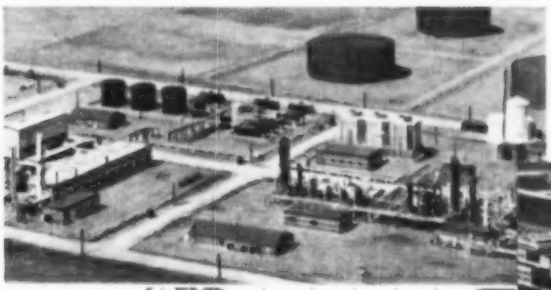
Government of Ireland is expected to announce the formation of a new company set up to build a refinery, supposedly at Whitegate, County Cork. A year ago, Eire's Ministry of Industry and Commerce announced that three companies had agreed to establish a company for operating a jointly-owned refinery. The companies are Esso Petroleum Company of Ireland, Ltd.; Caltex Ireland, Ltd., and Irish Shell.

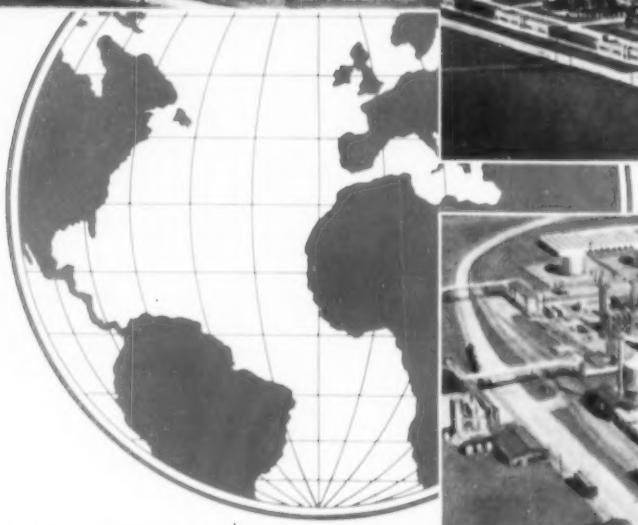
Regent Refining (Canada), Ltd., has let contracts totaling $5.5 million for additional refining facilities at Port Credit, Ont. The expansion centers around a new Fluid catalytic-cracking plant, which also includes a vacuum-distillation unit and a gas-polymerization unit.

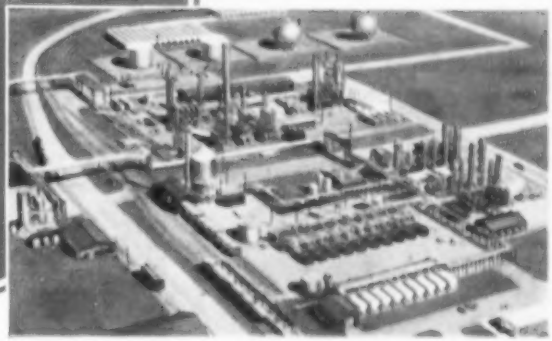
The main contractor is Procon (Canada), Ltd. Canadian Ingersoll-Rand gets

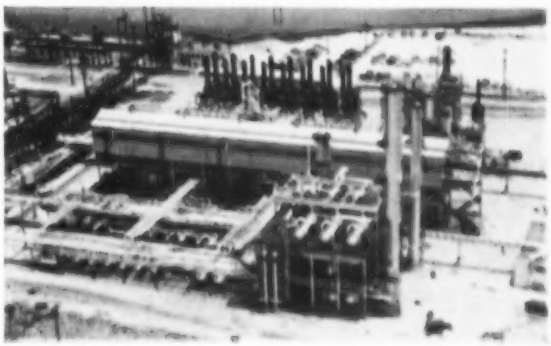
For more data on advertised products, use Readers' Service Cards, last page.

ETHYLENE—LOCATION and ECONOMICS









Stone & Webster Engineering Corporation has outstanding qualifications for appraising the economics of ethylene production for any location in this country or abroad.

To supply the rapidly expanding market economically and efficiently, five ethylene plants are at present being designed by the Corporation for clients located in four widely separated areas: the Gulf Coast, the Middle Atlantic States, Great Britain and France.

To the design and construction of these plants the Corporation brings the experience of 20 years in the production of ethylene from many different feedstocks, plus an extensive background in producing petrochemicals derived from ethylene and its by-products.

Write or call us for information as to how our experience can be of assistance to you.

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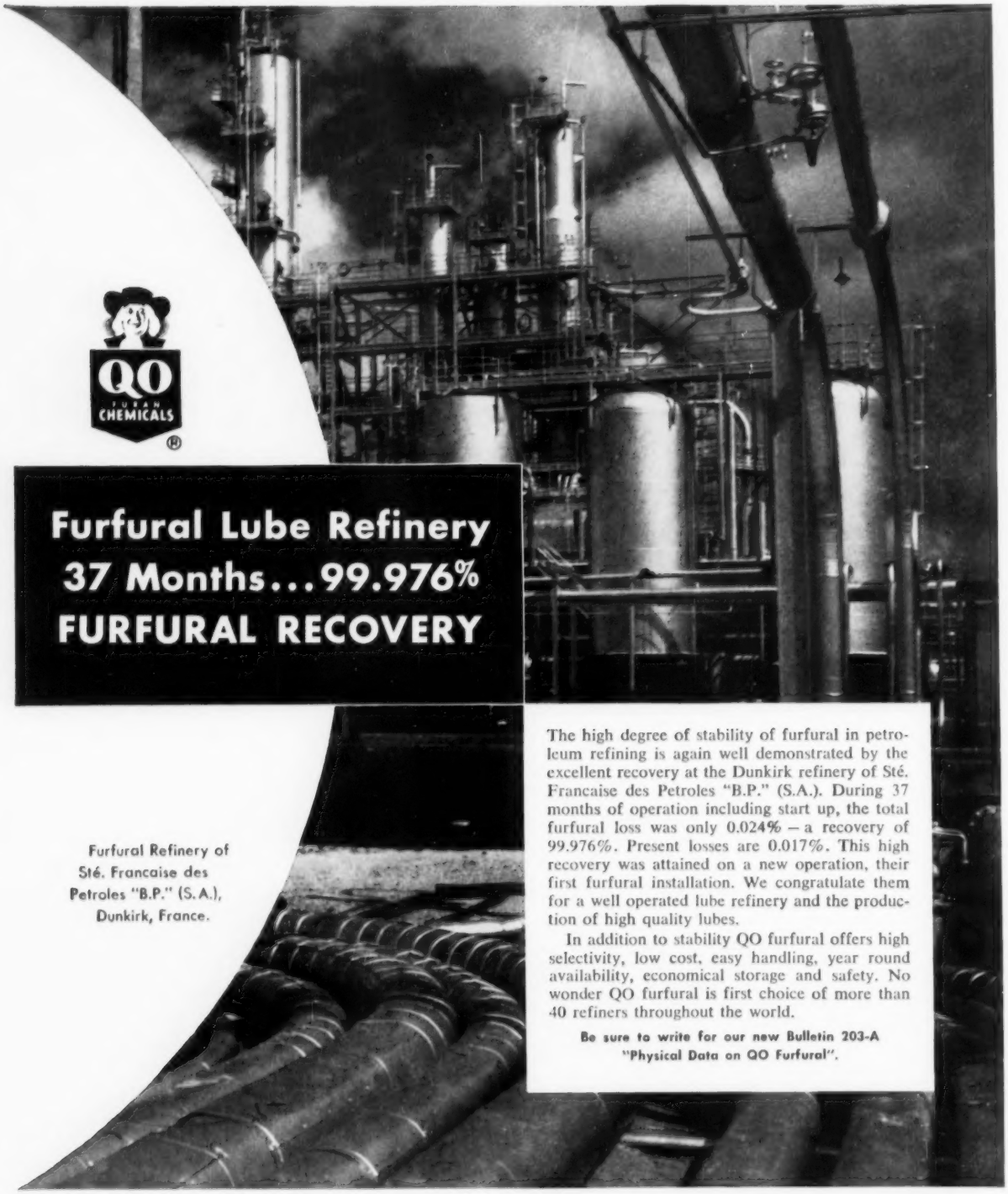

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Furfural Lube Refinery 37 Months...99.976% FURFURAL RECOVERY

Furfural Refinery of Sté. Francaise des Petroles "B.P." (S.A.), Dunkirk, France.

The high degree of stability of furfural in petroleum refining is again well demonstrated by the excellent recovery at the Dunkirk refinery of Sté. Francaise des Petroles "B.P." (S.A.). During 37 months of operation including start up, the total furfural loss was only 0.024% – a recovery of 99.976%. Present losses are 0.017%. This high recovery was attained on a new operation, their first furfural installation. We congratulate them for a well operated lube refinery and the production of high quality lubes.

In addition to stability QO furfural offers high selectivity, low cost, easy handling, year round availability, economical storage and safety. No wonder QO furfural is first choice of more than 40 refiners throughout the world.

Be sure to write for our new Bulletin 203-A "Physical Data on QO Furfural".

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Who's Building . . .

the contract for an air blower to compress 40 Mcf. of air a minute, and Toronto Iron Works, Ltd., will build the reactor regenerator.

The new facilities are expected to be in operation by January 1957. They will increase the refinery's present rated capacity from 14,000 barrels a day to 20,000 barrels.

Pennzoil Company will start up a new Platforming-Unifining unit at its 10,000-barrel-a-day refinery at Rouseville, Pa. The reformer has a design capacity of 2000 barrels a day.

The M. W. Kellogg Company plans to build facilities in Houston for making polyolefin plastics, using a process developed by Phillips Petroleum Company. A license agreement has been reached between Phillips and Pullman, Inc., parent company of Kellogg.

Plans call for the new facilities to be completed within 18 to 24 months. Kellogg will be using Phillips' new type catalyst for copolymerization of mixed olefins. In addition to using the catalyst in making new polyethylene, it will be the basis for developing new resin from olefins.

Texas Asphalt & Refining Company, planning an asphalt refinery for Pasadena, Texas, has awarded a contract for engineering and supervision of construction to Pona Engineers, Inc., a Houston firm. Engineering work on the 2500-barrel-a-day plant is about half finished, and Pona is due to start receiving bids for construction. The plant, to cost $1 million, is scheduled to begin partial operations in July 1956.

Socony Mobil Oil Company plans to add ten catalytic reformers, four alkylation plants and three hydrodesulfurization units to its refining facilities by 1958.

This year the company will spend $95 million, and another $67 million will be put into refineries in 1957. The $226-million expansion will be completed in 1958 with an outlay of $64 million.

Construction has been scheduled for a catalytic-reforming unit at the company's East St. Louis, Ill., refinery. And one of the hydrodesulfurization units will be installed at the refinery in Paulsboro, N. J.

The reformer, to employ the Sovaformer process, will have a rated capacity of 12,000 barrels a day. It will include a 16,000-barrel-a-day pretreater.

A contract for building the reformer went to The Fluor Corporation. Construction will start about mid-year, with completion due in early 1957.

The Paulsboro unit, which will have a 22,000-barrel-a-day capacity, will be completed in March 1957. It will be built by Foster Wheeler Corporation.

A second hydrodesulfurization unit, with a daily capacity of 5500 barrels, will be built at the affiliated refinery in Bremen, Germany. A contract for engineering and construction on this project was awarded to C. F. Braun & Company.

International Petroleum (Colombia), Ltd., planning a 25,000-barrel-a-day refinery at Mamonal, near Cartagena, will build a diversified plant. Main processing equipment for the $35-million refinery will be an atmospheric vacuum pipe still, a catalytic-cracking unit, light-ends and treating facilities, a polymerization and liquefied-petroleum-gas equipment.

The company, a subsidiary of Standard Oil Company (New Jersey) has named

LITHIUM METAL AND ALLOYS
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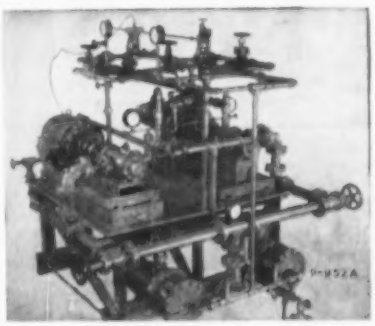

P-952-A—Steam Turbine and Electric Motor drive gives flexibility in this compact Model P-E52H size No. 25 unit.

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NATIONAL AIROIL Fuel Oil Pumping and Heating Units are specially designed to prepare, for combustion all grades all grades of fuel oil including No. 6 or Bunker "C" Oil and residuums. They will draw fuel oil from above ground or underground tanks, preheat it to proper constant temperature and deliver it to Oil Burners at an even pressure, best suited for the burners. Our Fuel Oil Pumping and Heating Units are the result of years of experience. They come completely equipped ready for steam, exhaust, condensate, oil suction, oil return, and electrical connections. All valves, regulators, etc., are readily accessible. The piping arrangement is easily understood. These compact, space-saving units are available in a range of sizes and models in both Medium and High Pressure types. For complete details, write for our Bulletin 4C—very interesting and informative.

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STEAM ATOMIZING OIL BURNERS
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DUAL STAGE, Combining steam and Mechanical Atomization
LOW AIR PRESSURE OIL BURNERS
AUTOMATIC OIL BURNERS, for small process furnaces and heating plants
GAS BURNERS
COMBINATION GAS & OIL BURNERS
FUEL OIL PUMPING and HEATING UNITS
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SHELL Launches New Safety Series

All over the country people are seeing Shell Better Driving Quizzes like the one on the right and those below.

Behind this new campaign lies Shell's conviction that part of our job—as a major supplier of gasoline and oil products—is to promote driving safety. That's why Shell started the famous "Share-the-Road" club back in the late 1930's. That's why we established the Carol Lane Awards for women's efforts toward traffic safety.

This new safety series urges the reader to test his reflexes, eyesight, knowledge of road signs, driving attitudes. No longer can the reader shrug off a safety message as written for "the other fellow." First indications are that these advertisements actually are helping many drivers think more seriously of their highway habits. That's a sure sign of a better future for all of us.

Can you tell a road sign by its shape?
Read and obey your signs of life!
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How far from the car in front should you be at 50 mph?
Stay Back! Don't Crowd Your Luck!
SHELL OIL COMPANY
See how fast you can move to the brake!
BRAKE
GAS
SHELL OIL COMPANY
Check your driving attitudes
STOP
Drive right...enjoy your right to drive
SHELL OIL COMPANY

4

6

1

TRY THIS BETTER DRIVING QUIZ!

It helps you relate your reaction time to safe driving speeds. Others in Shell's public service series on driving safety highlight such factors as courteous attitudes and recognition of road signs.

SHELL

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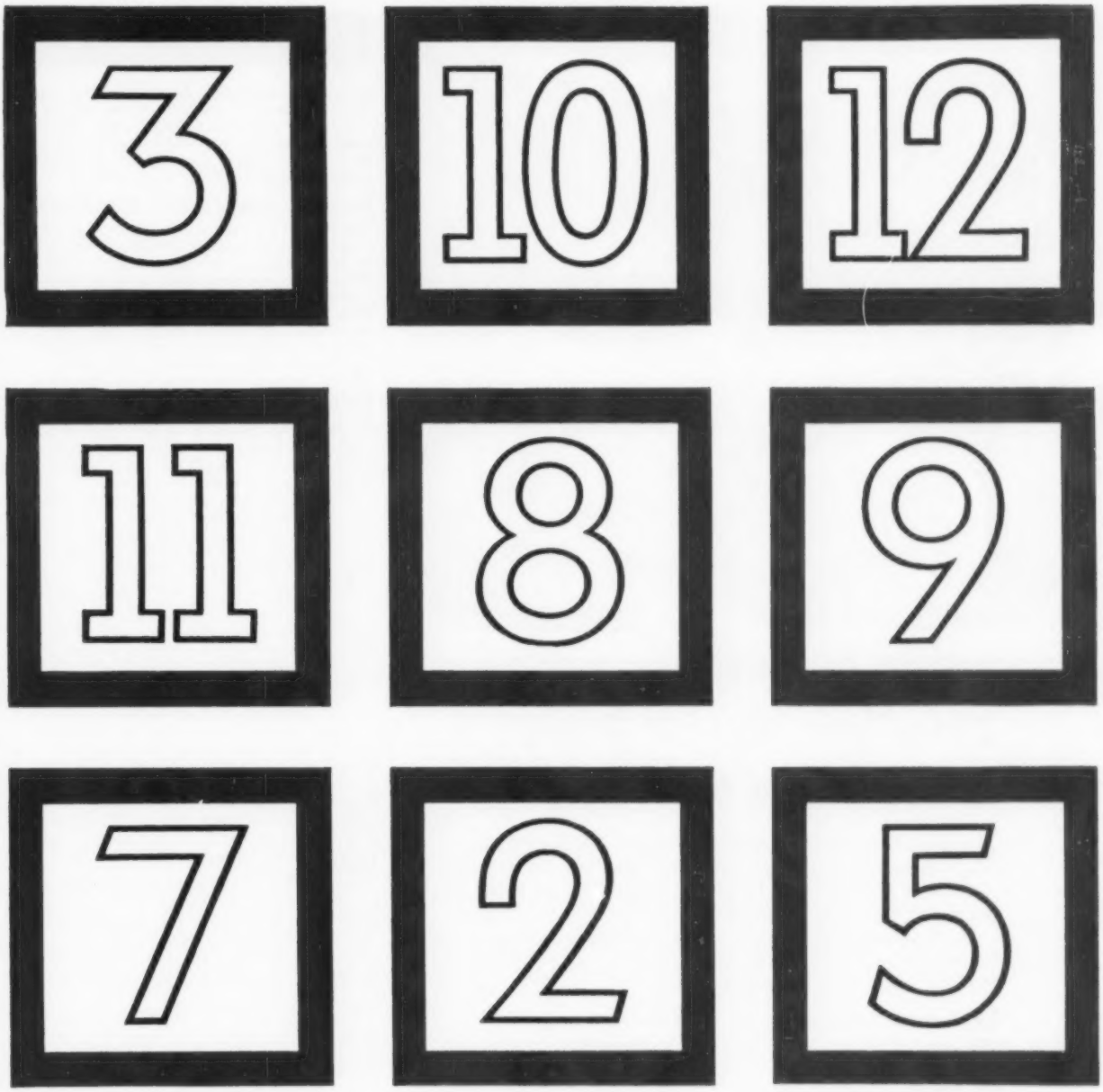

HOW FAST CAN YOU TOUCH EACH SQUARE IN NUMERICAL ORDER?

WITHIN 9 SECONDS? Your reflexes are about average.
WITHIN 7 SECONDS? Very good.
WITHIN 5 SECONDS? Excellent.

MORE THAN 9 SECONDS? YOUR REFLEXES ARE TOO SLOW. DON'T DRIVE OVER 45 M.P.H.*

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*Authority Dr. Herbert J. Stack, Director, Center for Safety Education, New York University

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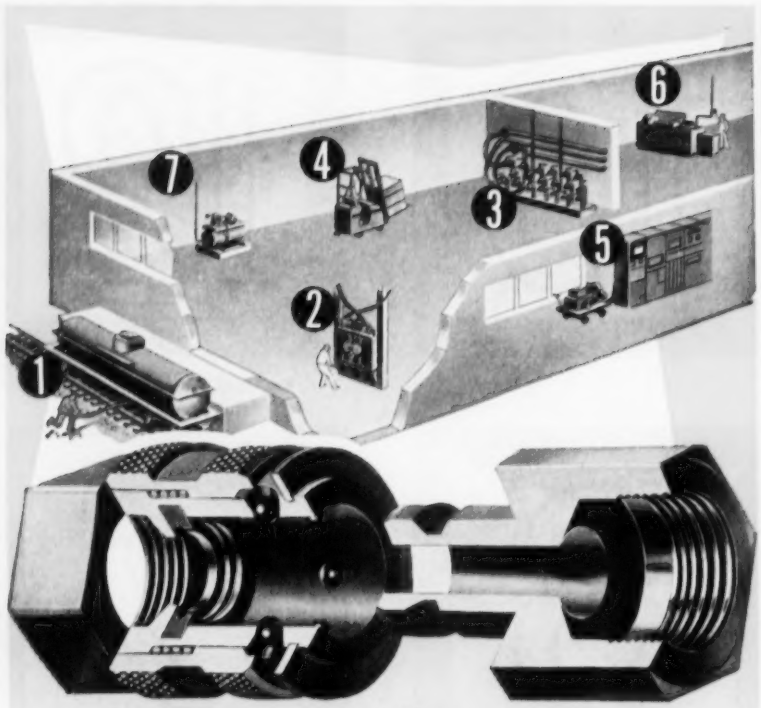

whatever the operation . . .

Titeflex Quick-Seal Couplings for fast, leakproof connections!

Everywhere in industrial operations, you find Titeflex Quick-Seal Couplings "making connections"! And what connections! *Absolutely* leakproof. Couple or uncouple in *one second*. Allow free flow of *any* material. Sizes ¼" to 12".

See drawing for typical uses. Then check your own plant for trouble spots where Quick-Seal Couplings can serve you *profitably*. For details . . . send coupon.

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2. Furnace Doors
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4. Lift Trucks—Hydraulic Lines
5. Mobile Testing Equipment
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Send me your free Quick-Seal Couplings Catalog—don't obligate me.

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Titeflex Quick-Seal Couplings • *Leakproof at all operating pressures, in every application*

Who's Building . . .

Bechtel Corporation's South American affiliate, Compania Bechtel, S. A., to perform engineering and construction. Early stages of construction will get underway in April. The refinery is scheduled for completion late in 1957.

Carbide and Carbon Chemicals Company, already building a new ethanolamines unit, will further expand its petrochemical operations at Seadrift, Texas, by increasing capacity of the ethylene-oxide plant. The project will bring the plant's total ethylene-oxide production to more than 200 million pounds a year. Additional capacity for making ethylene glycol will run 65 million pounds.

Hercules Powder Company plans to spend $25 million for construction in 1956, as compared to $13 million in 1955. The company's building program for 1956 and 1957 includes the following petrochemical facilities:

- A high-molecular-weight-polyethylene plant now under construction at Parlin, N. J. The new installation, a 30-million-pound-a-year plant, will use the Zieglar low-pressure process.
- Formaldehyde and pentaerythritol facilities at Louisiana, Mo. These units, already under construction, will turn out 100 million pounds a year of formaldehyde and 24 million pounds of pentaerythritol.
- Facilities to manufacture p-cresol at a new oxychemicals plant in Gibbstown, N. J.

Approximately 10 percent of the company's chemical output is based on petroleum.

Frontier Refining Company has gone on stream with a new Platformer and Unifining unit at its refinery in Cheyenne, Wyo. Both units are electronically-controlled.

Electronic instrumentation was used because pneumatically-controlled instruments often freeze during the Wyoming winters. The new installation is the first in a U. S. refinery to include liquid-level indications transmitted by electrical impulses. On other electronic-instrument installations the level transmission has been pneumatic.

Fresh feed to the 2000-barrel-a-day Platformer is naphtha derived from Wyoming crudes. The naphtha, boiling in the range of 180 to 400 F., is converted into high-octane blending component.

The Unifiner was designed for alternate operations charging either 3000 barrels a day of 375 to 560 F. high-sulfur straight-run distillate, or 2500 barrels of 400 to 650 F. mixed straight-run distillate and catalytically-cracked cycle oil. The unit was placed on stream charging 2500 to 2700 barrels a day of straight cracked cycle stock.

Procon, Inc., built the Platforming and Unifining units. They were designed by Universal Oil Products Company, which also designed the installation of the electronic instruments.

Cosden Petroleum Corporation has placed on stream a 2100-barrel-a-day Unifining unit at its Big Spring, Texas, refinery. The unit, pretreating a high-sulfur naphtha, will be used to supply feed stock to a 3900-barrel-a-day Rexformer, now under construction.

Cosden is operating a Platformer integrated with a Udex unit. The former fa-

For more data on advertised products, use Readers' Service Cards, last page.

Who's Building . . .

cility is running on a blocked off basis to produce motor fuel and aromatics.

When the Rexformer goes into operation, the Platformer will process only light naphthas for preparation of aromatic feed stock to the Udex unit. The Rexformer will process heavy naphthas for conversion into high-octane blending component.

Ceylon Government is negotiating with four international companies for construction of a 21,000-barrel-a-day refinery. Only details remain to be worked out with the Royal Dutch/Shell Group, The British Petroleum Company, Ltd., Standard-Vacuum Oil Company and California/Texas Oil Company. The refinery, expected to go on stream in 1958, will have a daily capacity of some 21,000 barrels.

Industria Raffinazione Olii Minerali, Italian affiliate of The British Petroleum Company, Ltd., has gone on stream with a 2000-barrel-a-day Platforming unit at its Porto Marghera refinery near Venice. The prime contractor was Procon (Great Britain), Ltd.

International Synthetic Rubber Company, Ltd., a new company, has been formed to make synthetic rubber in Britain on a commercial scale. Companies which have agreed to join in the project are Dunlop Rubber Company, Goodyear Tire and Rubber Company (Great Britain), Firestone Tire and Rubber Company and Michelin Tire Company.

Britain on a commercial scale. Companies

Production is scheduled to start in 1958, and it is expected that initial output will run about 50,000 tons a year of general-purpose synthetic rubber.

This will be Britain's first venture in the production of general-purpose synthetic rubber, although pilot plants and small production units have been built or under construction to make synthetic rubber for special purposes. Dunlop, for example, has a 2000-ton-a-year plant, and Monsanto runs one with an annual output of 4000 tons.

The Standard Oil Company (Ohio) is considering a major refinery expansion. Engineering studies for the project are being carried out by the company's technical staff. Sohio's refining operations are centered at Cleveland, Lima and Toledo, Ohio.

Societe Rhone-Poulenc of France, with Societe Kuhlmann, will build a polyethylene plant in France, using the low-pressure process licensed by Phillips Petroleum Company. Location or capacity of the plant was not available.

Esso Standard Oil Company is ready to start construction on the first catalytic-reforming unit at its Linden, N. J., refinery. The unit, to be a 20,000-barrel-a-day fixed-bed Hydroformer, will be the largest of its kind in commercial operation.

The process, developed by Esso Research & Engineering Company, also will be used for an 8000-barrel-a-day reformer to be installed at the Montreal refinery of Imperial Oil, Ltd. This company is another affiliate of Standard Oil Company (New Jersey).

Only two other units of this type have been built. One is a 3000-barrel-a-day unit in operation at Esso Standard's Baltimore

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Can take grueling punishment from corrosive fluids, high temperatures, excessive vibration and pressures . . . or from any combination of these industrial *spoilers.* All-metal construction. Wide range of sizes. Braided or unbraided. Choice of alloys and fittings to meet *every* need.

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TITEFLEX FLEXIBLE METAL HOSE licks corrosion temperature vibration pressure *in all industrial operations*

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A 13,000 cfm direct-fired air preheater being assembled at our Elizabeth plant. The stainless steel combustion chamber (not shown) sets below the tube banks. Air exit temperature 1000° F.

OUR EXPERIENCED ENGINEERS are available to expedite planning and specification work and to suggest the most suitable and economical exchanger design.

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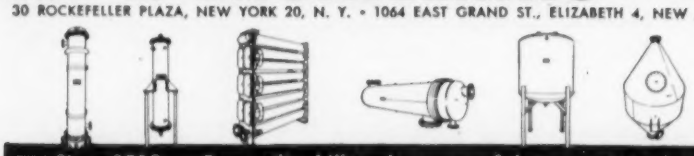

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Who's Building...

refinery; the other, with a daily capacity of 2500 barrels, is in operation of the Carter Oil Company plant at Billings, Mont. Carter also is an affiliate of Jersey Standard.

Solway Process Division, Allied Chemical & Dye Corporation, expects to go into production this spring with its new vinyl-chloride-monomer plant at Moundsville, W. Va. The plant will use a new process developed jointly with Allied's Nitrogen division.

Hydrogen chloride will be obtained from Solway's chloromethane operations, while acetylene will be piped from an installation being erected nearby by Linde Air Products Company. The vinyl chloride will be used in making polyvinyl-chloride thermoplastic resin.

Syrian Government has received offers from a number of countries to build its projected refinery at Homs. Bids came from the U. S., United Kingdom, France, Soviet Union, Czeckoslovakia and Rumania. The government, planning a 15,000- to 20,000-barrel-a-day refinery, has set aside $20 million for the project.

Raffinerie Belge de Petroles will add combination catalytic-desulfurization and catalytic-reforming facilities to its refinery at Antwerp. Engineering and construction on the Belgian project will be done by Kellogg International Corporation. The new unit will use a Sinclair-Baker platinum reforming catalyst.

General Petroleum Corporation is planning to add a second Sovaformer and a distillate-treating unit to its new refinery at Ferndale, Wash. The work, to be completed in 1957, is part of a $9-million expansion program scheduled for the refinery.

The reformer will have a daily capacity of 9000 barrels. The present reformer is a 6000-barrel-a-day unit. The other new unit will treat light straight-run gasoline and naphtha.

Alba, S. A., a Brazilian concern in which Borden Company holds a majority interest, will launch a $3.5-million building program at Cubatao, to produce methanol, formaldehyde and synthetic resins. The company already has petrochemical production at Curitiba.

The new plant, which will go into operation in 1958, will have a daily capacity of 30 tons of methanol. It will more than double Alba's production of formaldehyde and synthetic resins.

Heyden Chemical Corporation has started construction at Fords, N. J., of a new plant with an annual capacity for 25 million pounds of pentaerythritol. The plant, which will use a new process, is being erected adjacent to the company's present plant which produces formaldehyde and other organic chemicals. Production is scheduled for March 1957.

Societe Francaise des Petroles plans to install a new atmospheric-distillation unit at its refinery in Lavera. The company, an affiliate of The British Petroleum Company, Ltd., also will build a catalytic-reforming unit at its Dunkirk refiner.

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we never underestimate the creative in construction . . .

Building petroleum refineries, petrochemical and chemical plants requires complete understanding of practical construction techniques. You know, and we know, that there is no substitute for experience, a thorough knowledge of tried-and-proved methods, in this business. But, there is an important something beyond this, too.

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WORLD-WIDE CONSTRUCTION FOR THE PETROLEUM, PETROCHEMICAL, AND CHEMICAL INDUSTRIES

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As Management Sees It . . .

In 1945 . . . Cracking coils and tankage at the Stanvac refinery in Indonesia shown after Allied bombers scored a direct hit in April, 1945. The refinery was then operated by Japanese occupational forces.

In 1953 . . . General view of the gasoline-treating plant and cracking coils at the Indonesian refinery after its postwar rehabilitation.

Standard-Vacuum's Achievement . . .

Postwar Construction in Five Countries

STANDARD-VACUUM Oil Company, at the close of World War II, had no refining operations. The company's only refinery—a 45,000-barrel-a-day plant in Indonesia—had fallen into Japanese hands.

Today—just ten years later—Stanvac's daily refining capacity is 181,500 barrels. The company is operating six refineries in five countries of the Eastern Hemisphere.

Here's the boxscore on Stanvac's ten years of postwar growth:

1947—Re-opened the Sungei Gerong refinery at Palembang, Indonesia.

1949—Put a new refinery on stream at Altona, near Melbourne, Australia.

1950—Purchased a major interest in and completely renovated two war-damaged refineries in Japan.

1954—Started operations at new refineries in Durban, South Africa, and Bombay, India.

Standard-Vacuum Petroleum Maatschappij resumed operations at Palembang a year after it regained control of the wrecked refinery and repair crews had started to work.

The refinery was a mess when officials of SVPM, Standard-Vacuum's affiliate in Indonesia, saw it again after four years. It had been wrecked under Dutch military orders when the Japanese attacked in 1942, and it was hit hard again when U. S. bombers returned the war to Indonesia.

Once the largest U. S. refinery in the Far East, Sungei Gerong was started up again at less than half its prewar capacity. Not only was the refinery damaged by war, but while the Japanese were in possession there had been practically no effort at maintenance. As a result, not only did missing and damaged parts have to be replaced, but almost all the equipment had to be overhauled.

For the past ten years, refining companies all over the world have been expanding and improving their plants, in a never-ending effort to meet the postwar demand for petroleum products. This is another in the PETROLEUM REFINER's series on the companies that are leading in construction to meet that demand.

Within eight months, however, repair crews had returned output to its full 45,000 barrels a day. Since then, through removal of bottlenecks the refinery has been able to gain an additional thruput of 20,000 barrels a day.

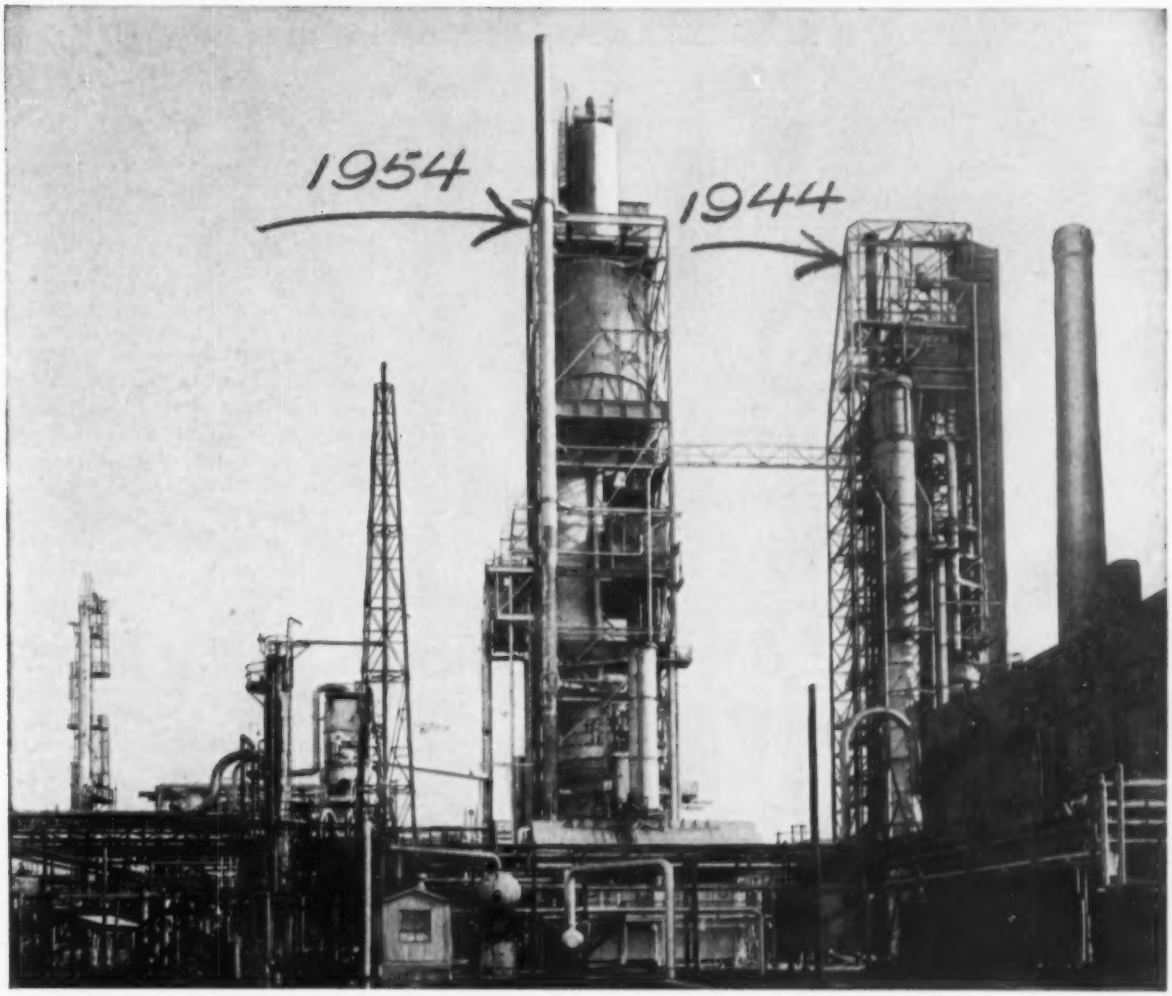
A heavy investment was made in renovating the Sungei Gerong refinery, but no new processing equipment was installed. Except for recent additions, the refinery stands today very much as it did before World War II.

It consists of two shell-still batteries for crude topping, two vacuum pipe stills in series and two small pipe stills for crude and rerunning; four tube and tank thermal-cracking coils, two Edeleanu plants and an alkylation unit; a compressor plant and other light-end facilities; a 40,000-ton-a-year wax plant; sulfuric acid facilities and the usual treating equipment, with steam- and power-generating units and other utilities.

Scheduled work to be carried out at Palembang in 1956 and 1957 includes a complete revamping of the existing plant, with the installation of a polymerization plant and fluid catalytic-cracking unit. This work is expected to cost some $20 million. The refinery originally cost about $30 million.

In 1949, Standard-Vacuum's marketing subsidiary in Australia, Vacuum Oil Company, Pty., Ltd., built and began operations of a 2000-barrel-a-day lubricating oil plant and asphalt refinery at Altona. Later this was taken over by Standard-Vacuum Refining Company (Australia) Pty., Ltd., which by 1955 expanded it to a 27,500-barrel-a-day fuel-products plant, giving Stanvac's Australia affiliate one of the most modern refineries in the Eastern Hemisphere.

This major expansion cost a total



NEW T.C.C. UNIT JOINS 10 YEAR OLD SISTER AT EAST ST. LOUIS REFINERY

Two Thermofor Catalytic Cracking Units stand here side by side at Socony Mobil Oil Company's East St. Louis refinery, where for 10 years one stood alone. Both were engineered and constructed by The Lummus Company.

The first unit, with 10,000 B/D total charge and bucket lift for catalyst, went on stream in 1944 and has operated satisfactorily ever since.

The second unit, complete with feed preparation, fractionation, and gas recovery sections and using gas lift for catalyst circulation, went on stream in November 1954. Its total charge is 15,000 B/D.

We feel that the confidence which Socony showed in choosing Lummus for the repeat unit, and the installation of other East St. Louis facilities at the same time, was justified by our performance on the job.

Working closely with Socony engineers at the refinery and in their main office in New York, Lummus performed all work with a minimum of interruption to normal refinery operations – thus maintaining maximum possible refinery production.

The construction proceeded smoothly without interruption, and start-ups of the separate units were in line with a pre-established schedule, dovetailing them with periodic refinery maintenance shutdowns.

Perhaps this suggests some ways in which Lummus might serve you when you consider new or expanded facilities.

The Lummus Company, 385 Madison Avenue, New York 17, New York. *Engineering and Sales Offices:* New York, Houston, Montreal, London, Paris, The Hague, Bombay. *Sales Offices:* Chicago, Caracas. *Heat Exchanger Plant:* Honesdale, Pa. *Fabricated Piping Plant:* East Chicago, Ind.

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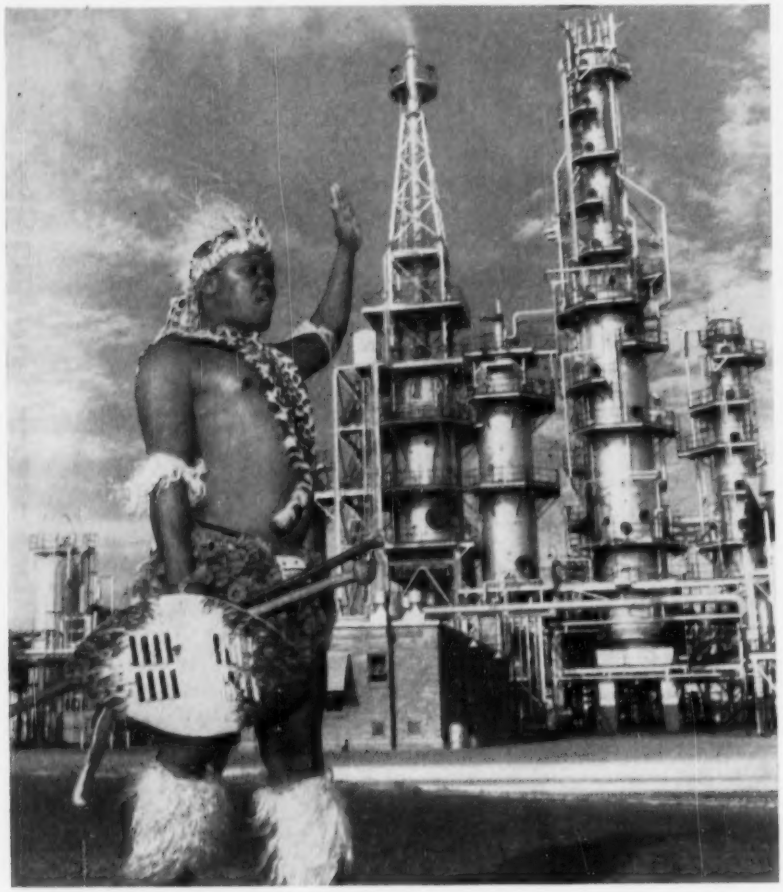

A Zulu refinery worker, decked out in tribal regalia, poses in front of the fluid combination unit at Stanvac's refinery in Durban, South Africa. The plant had an average daily crude run of 19,600 barrels in 1955.

of $30 million. Cost of the original Altona refinery had run about $3 million.

In addition to a crude-distillation unit which will handle 25,000 barrels a day, Stanvac installed a 18,000-barrel-a-day (charge to reactor) Thermofor catalytic-cracking plant. Later a catalytic-reforming unit was erected, and early this year the company completed the installation of alkylation facilities.

The reformer, a 5400-barrel-a-day Sovaformer, cost an additional $5 million, and the alkylation unit ran the total investment at Altona to about $42,600,000.

Construction on the project was started in November, 1952, with actual work on the process area beginning in January, 1953. Contractor for the over-all job was Braun Transworld Corporation, a subsidiary of C F Braun and Company.

In Japan, Standard-Vacuum acquired a majority interest in Toa Nenryo Kogyo, Ltd., a company with two refineries which had been put out of commission during the war. When these refineries were returned to operation in 1950, they gave Stanvac an increase of about 15 percent in its total refining capacity.

Together, the refineries at Wakayama and Shimizu had a daily crude capacity of 10,000 barrels. This has since been increased—primarily through construction at Wakayama—to a combined output of more than 40,000 barrels a day.

The Wakayama refinery was started up with a daily capacity of 6000 barrels. Later this was increased to 12,000 barrels, and in 1954 the company installed additional distillation facilities, pushing capacity up to 35,000 barrels a day.

Also a fluid Hydroformer went on stream in March, 1955, and a fluid catalytic-cracking plant is due for completion at Wakayama in December, 1956.

The refinery at Shimizu was returned to operation at a daily capacity of 4000 barrels. This has since been increased to 6000 barrels. Other work at Shimizu has included revamping the refinery's lube-oil facilities.

Both the Durban and Bombay refineries were built in countries which had been forced to import almost all their finished petroleum products. The Durban refinery is now able to furnish about a fifth of the products consumed in South Africa, and the refinery at Bombay supplies some 30 percent of India's petroleum needs.

The South African plant, based on a crude rate of 19,600 barrels a day, yields some 8200 bpd of gasoline, 1000 barrels of kerosene, 3900 barrels of diesel oil, 4800 barrels of fuel oil and 400 barrels of asphalt.

The plant was built by the affiliated Standard-Vacuum Refining Company of South Africa (Pty.), Ltd. Construction was started in January 1952, and the refinery went on stream two years later. Foster Wheeler, Ltd., was the main contractor.

Built at a cost of $25 million, the South African refinery was one of the first to integrate a fluid catalytic-cracking unit with atmospheric-crude-distillation and thermal-reforming facilities. The same type combination equipment was installed in Bombay.

The Bombay installation is a 30,000-barrel-a-day refinery on Trombay Island in Bombay harbor. Built at a cost of $35 million, it was the first multi-product refinery in India.

It is owned and operated by Standard-Vacuum Refining Company of India (Pty.), Ltd., a Stanvac affiliate in which private Indian capital holds a 25 percent interest.

Of the refinery's output, 2,574,000 barrels a year is gasoline; 1,144,000 barrels kerosine, 1,687,400 diesel oil; 1,658,800 fuel oil, and 1,401,000 barrels bunker oil.

Principal contractor for the Indian project was The Lummus Company.

And now Stanvac is turning its attention to a sixth country of the Eastern Hemisphere. In the Philippines, negotiations are underway for construction of what will be Stanvac's seventh refinery. Present plans call for the Philippine refinery to be built for a daily capacity of 20,000 barrels.

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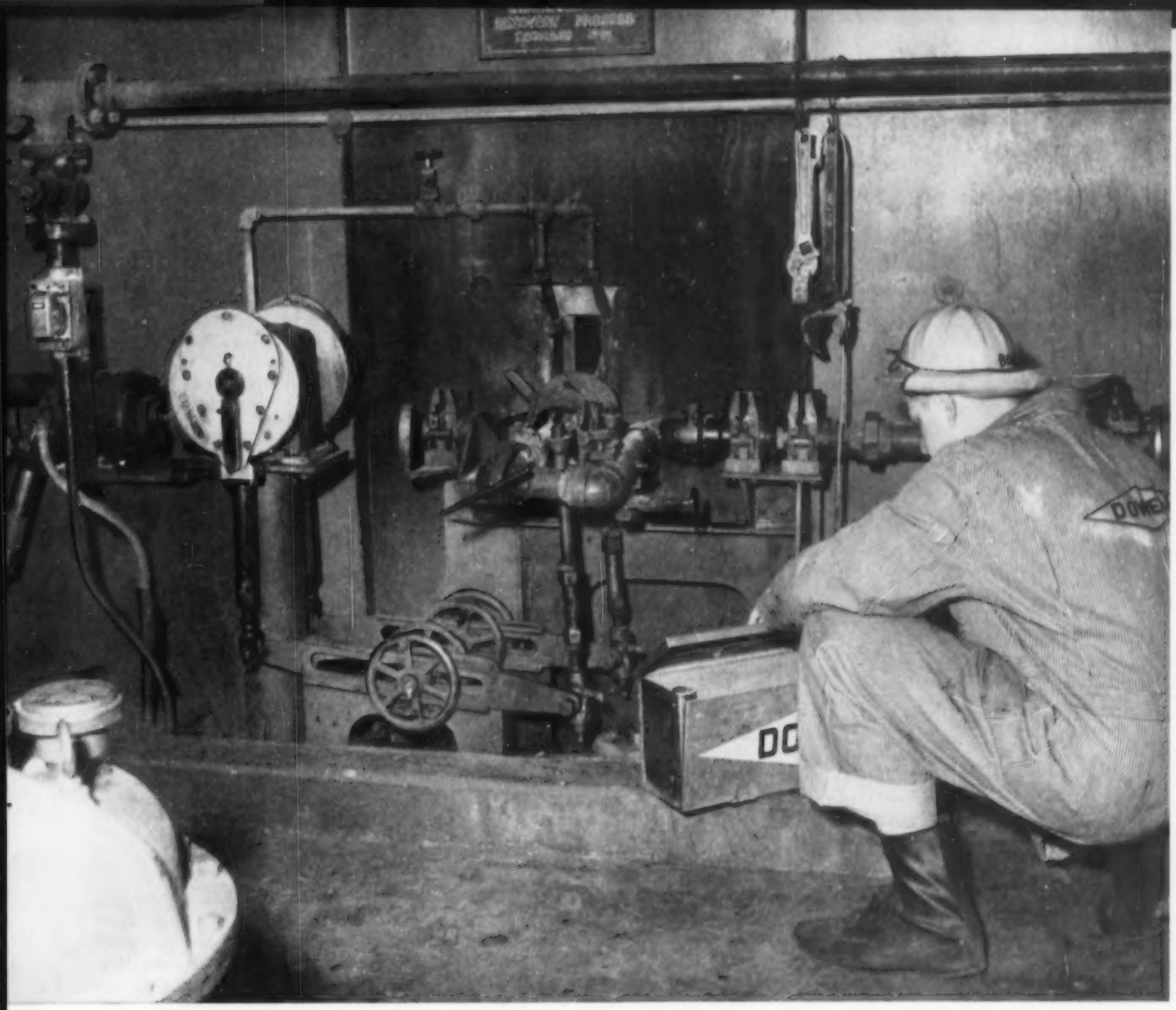

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What are they concerned about?

First, they want to know they are getting the benefits of experience. These benefits include less downtime and more thorough cleaning. Dowell has this experience with over 15 years and 10,000 boilers alone to their credit. In saving downtime, Dowell often cleans equipment while it is in operation.

Next, these companies want to be sure their men and equipment have the greatest possible protection. Dowell excels here, too. For safety is foremost in the Dowell engineer's mind. Thoroughly trained, he uses only the latest safety methods and equipment. He works closely with your safety personnel to establish safest possible working procedures.

Be sure you are getting maximum results with maximum protection in your chemical cleaning.

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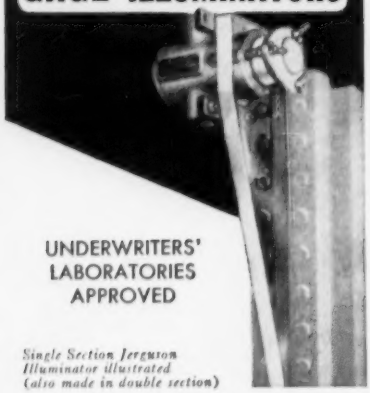

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Jerguson Illuminators are approved by Underwriters' Laboratories and are built in accordance with their Standard for Electric Lighting Fixtures for use in hazardous locations for Class 1, Group D Services. Made in a variety of sizes; also available in a non-explosion proof model.

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Here's how management can avoid . . .

Pin Pricks From Within

Without sound internal employe relations, a company's external public relations program can be rent asunder.

By William S. Wilcox
University College, Rutgers University, Newton Square, Penn.

EXTERNAL PUBLIC relations is a composite of what people *outside* a company *think* about it—and internal public relations is derived from what people *inside* a company *know* about it.

The everyday relationships within a company create the atmosphere of internal public relations. The external form is a gossamer cloak that can be rent asunder by pin pricks from within. Productive external public relations begins internally with employes.

The genesis of the need is well known. It took root in the early '90's in Chicago. Anyone who has read Upton Sinclair's book, "The Jungle" will recall the terrifying economic pressure and the stark misery of the lives of the stockyard workers—their utter dependency on their employers for life itself—the tragedy of unemployment and the anti-labor attitudes in those days. "The Jungle" brought the archaic employe relations of an entire industry to the court of Public Opinion. Shortly thereafter the old Muncey's Magazine ran a series of articles on the price being paid for steel in human blood, so many drops per pound of metal. The two together started the safety and the personnel movements of Ameircan industry. The employe relations of the two industries had violated the public's sense of right. Sometime later, one of

A Good Supervisor Must:

- **Possess the right balance between sternness and familiarity.**
- **Know how to control his temper.**
- **Give clear directions and follow up the work without nagging.**
- **Be careful to give credit to others for their ideas.**
- **Keep the few promises that he makes to his men and see that those promises made by management are carried out.**
- **Administer reprimands in private, talk straight to the point and not harbor a grudge.**

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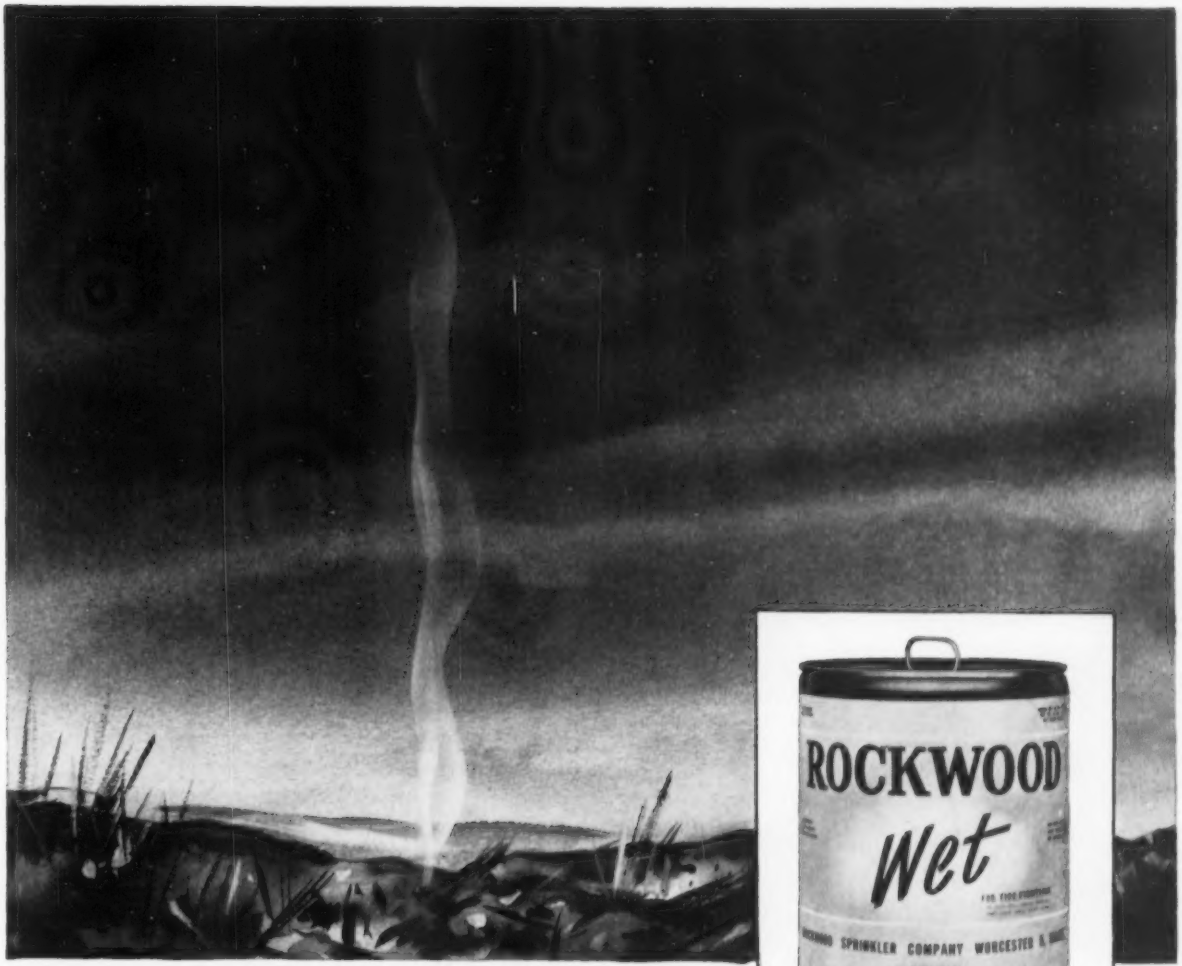

Rockwood Wet — a wetting liquid specially prepared for fighting deep-seated fires. Available in 50 gallon drums, 5 gallon and 1 gallon cans.

A fire fighter knows better

Water alone won't do it! The most effective way to fight this type of fire is to add Rockwood WET to the water.

It's the most effective way, because Rockwood WET increases the fire extinguishing action of water. The result is quick extinguishing, reduced rekindling — in less time . . . with less water!

The remarkable penetrating power of Rockwood WET reaches the very seat of the fire. And Rockwood WET retains its great depth of penetration even at fire temperatures. Tested and listed by Underwriters' Laboratories, Inc., Rockwood WET has proven its effectiveness against deep-seated fires in wood, paper, sawdust, cloth, rubber, etc.

You can use Rockwood WET in proportion of 1% for Class A fires and 2% for Class B fires. The Rockwood eductor and proportioner is specially designed for this purpose. It *automatically* proportions liquids at any fixed percentage, from 1% through 6%.

Put this fire fighter to work for you! For complete details write today for Rockwood's free illustrated catalog. Distributors in all principal cities.

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Engineers Water . . . to Cut Fire Losses

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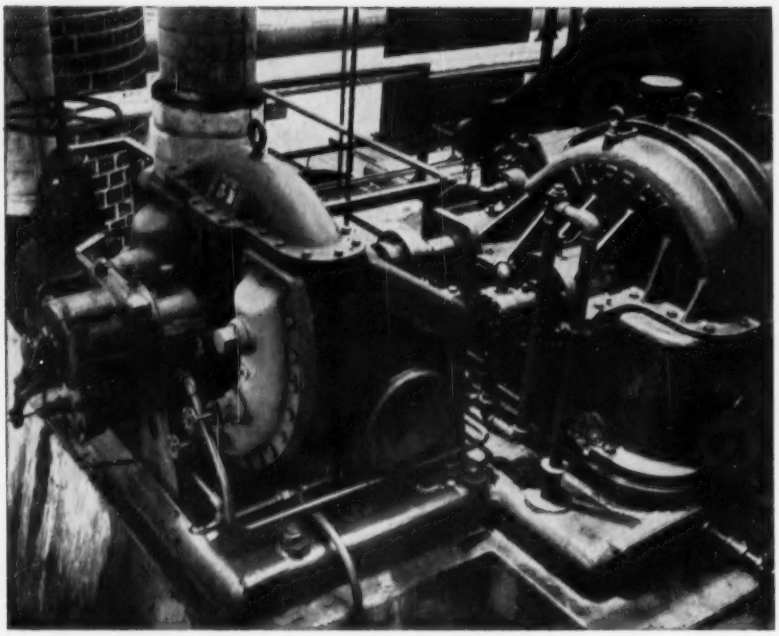
Murray Turbines



One of 4 Murray type u turbo-gear units installed in a southwest rubber plant still giving trouble free service after 12 years in an unprotected outdoor location. This unit drives an Induced Draft Fan requiring 425 HP at 683 RPM. The turbine speed is 3500 RPM.

• Murray turbo-gear units for mechanical drive are right at home in difficult outdoor installations. Fans, pumps, compressors, and many special types of slow speed machines are among the long list of installations powered by Murray turbo-gear units.
Murray gears are of the Herringbone or Double Helical type and all are pressure lubricated at the point of tooth contact.

MURRAY IRON WORKS COMPANY
BURLINGTON, IOWA

Builders of Steam Power Equipment for Three Quarters of a Century

As Management Sees It . . .

the bloodiest strikes and labor disturbances in our country's history took place in Colorado, on the properties of the Colorado Fuel and Iron Company.

An outgrowth of this disturbance was the first Employe Representation Plan in this country where employes' ideas and advice were openly solicited and freely given. All of the elements of a sound employe relations program had their inception in the three incidents described—and as a result the external public relations of the industries involved have improved immeasurably ever since.

It is quite clear why a thought-through employe relations program is needed in companies where the number of employes is so large top management does not have time for every individual employe. The why can be stated about as follows:

"To accomplish the mission of the company with less friction, less delay, and through more intelligent cooperation."

Whenever a person hires another to do work, a relationship is started that is different but nevertheless dependent upon the human relationship between two people. The hired man must be selected, and, if necessary, trained for the duties of the work. He must be in agreement with the pay he is to get and his hours of work must be understood if only that they are indefinite. He must know what he can and cannot do on the job in order to protect his employer's interest and safeguard his own welfare. The human relationship must be fair and reasonably satisfactory to both.

The next step is to establish a simple but effective employe relations program. There are three sound principles to follow:

1. Don't do anything for an employe that he can and should do for himself.
2. Don't permit employe relations' activities to undermine the responsibility that a supervisor has for handling his own human problems in a human manner.
3. Don't bypass a supervisor's authority over his people until he refuses to, or is incapable of functioning for management.

Supervisors and other members of

For more data on advertised products, use Readers' Service Cards, last page.

A Specialized Engineering Service to STOP

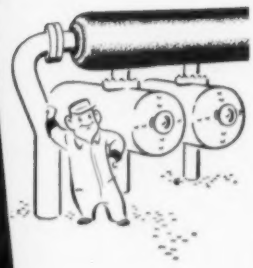
NOISE—

—from intake or discharge of air, steam or gas piped to atmosphere.
—from engines, compressors and vacuum systems.

and

PULSATION—

—from surges created by compressors, pumps, blowers and pressure reduction systems.



The Burgess-Manning Snubbing Principle has, for many years, been engineered to varied problems of noise and pulsation in every branch of the petroleum, chemical, power and general industries. Noise and pulsation has been completely eliminated—production has been greatly increased, maintenance reduced with neighbor and labor relations improved.

Here is an engineering service, backed by years of experience and a proved principle of snubbing that will prevent and eliminate noise and pulsation problems.

We invite you to present your problems for recommendations.

Write for your copies of case histories of representative installations and see the results for yourself.

BMM Sound Engineering

BURGESS-MANNING COMPANY

711 East Park Avenue, Libertyville, Illinois
Dallas, Texas

So SIMPLE We Can Adapt It to ANY LIQUID LEVEL CONTROL JOB

A sleeve, raised and lowered within a non-magnetic tube, attracts or releases an Alnico magnet attached to a mercury switch. Basically, this is Magnetrol.

MAGNETROL

AS DEPENDABLE AS MAGNETIC FORCE ITSELF

● No matter how specialized the liquid level control application, adapting Magnetrol to meet it presents no problem. Whether it's for high pressures, high temperatures, corrosive liquids or any other condition, a few "standard" modifications and the job is done! Operation is so simple no changes in basic design are needed. That's why Magnetrol "fits" practically any application — why "specials" are so often standard with us.

Because of the utter simplicity and dependability of its magnetic principle, Magnetrol has *infinite operating life.* There are no wearing parts to get out of order.

Magnetrols are available for controlling level changes from .0025-in. to 150-ft., with single or multi-stage switching. Our experienced engineering staff is at your service.

MAGNETROL, Inc.

WHY NOT MAIL THE COUPON—NOW

MAGNETROL, Inc., 2112 S. Marshall Blvd., Chicago 23, Illinois
Please send me catalog data and full information on Magnetrol Liquid Level Controls.

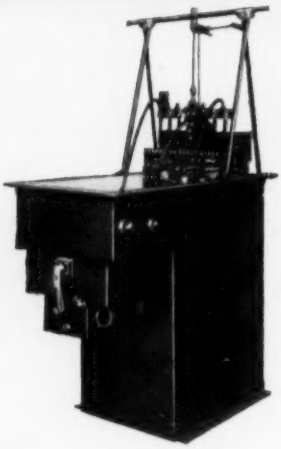
Name_____
Company_____
Address_____
City_____ Zone____ State____

For more data on advertised products, use Readers' Service Cards, last page.

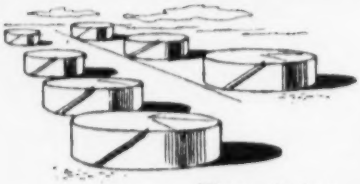
BUILT TO THE REQUIREMENTS OF OIL MEN

EC&M

TOTALLY OIL IMMERSED 50,000 KVA interrupting capacity MOTOR STARTERS *have many advantages*



Contactor and Relay Panel are bolted together for raising as a unit above the oil. No leads or bolts to disconnect. Shown is Cat. No. 2645A Lifting Mechanism, available at small cost.

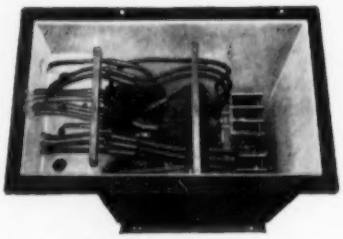


These starters are designed specifically for Division 2, semi-hazardous locations. They are low in first cost and are easy to service when inspection or maintenance are necessary. They require little floor space.

High interrupting capacity is inherent . . . 50,000 KVA and no power fuses required. The well-known Type ZHS Magnetic Contactor has been certified for this rating. It is of heavy-duty construction to assure trouble-free operation.

Before buying 2300-5000 volt motor starters, investigate EC&M Type ZHS Starters. They provide economy in installation, operation and maintenance, and are available in a range of horsepower sizes.

Write for Bulletin 1062-20.



Looking down into starter showing anti-syphon lead construction from contactor, control transformer and overload relay panel to conduit connection box with threaded couplings. Starter with oil disconnect switch shown in views above.

6886 EC&M

THE ELECTRIC CONTROLLER & MFG. CO.

Division of Square D Company

4498 LEE ROAD • CLEVELAND 28, OHIO

As Management Sees It . . .

management have a natural tendency to become so absorbed in their specialties that they can lose their awareness of employes as individuals. This is a truism irrespective of the size or degree of expansion of an organization.

Without attempting to detail the contents of a minimum formalized employe relations program in this article, it should be an accepted practice to put into writing any policy affecting employes, however brief, if the policy is believed in by management and intended for actual observance. The policy should be placed in the hands of employes and supervisors alike.

Who operates an employe-relations program? The supervisor is the man responsible for the functions as they apply to his own employes—first, last and always. A minimum of his employe relations capabilities should include:

- The right balance between sternness and familiarity.
- Know how to control his temper.
- Give clear directions and follow up the work without nagging.
- Be careful to give credit to others for their ideas.
- Keep the few promises that he makes to his men and see that those promises made by management are carried out.
- Administer reprimands in private, talk straight to the point and not harbor a 'grudge'.

A supervisor needs to be all of the foregoing because he must be everlastingly watchful for the pin pricks from within that cause irritation and poor internal public relations. These include, but are not limited to:

1. Pay rates

Paying less than competitive rates for the same work
Paying less than subsistence rates
Paying different starting rates for the same job
Paying no attention to pay rates

2. Hours of work

Work hours longer than competitive plant
Excessive overtime
Starting and closing time out of

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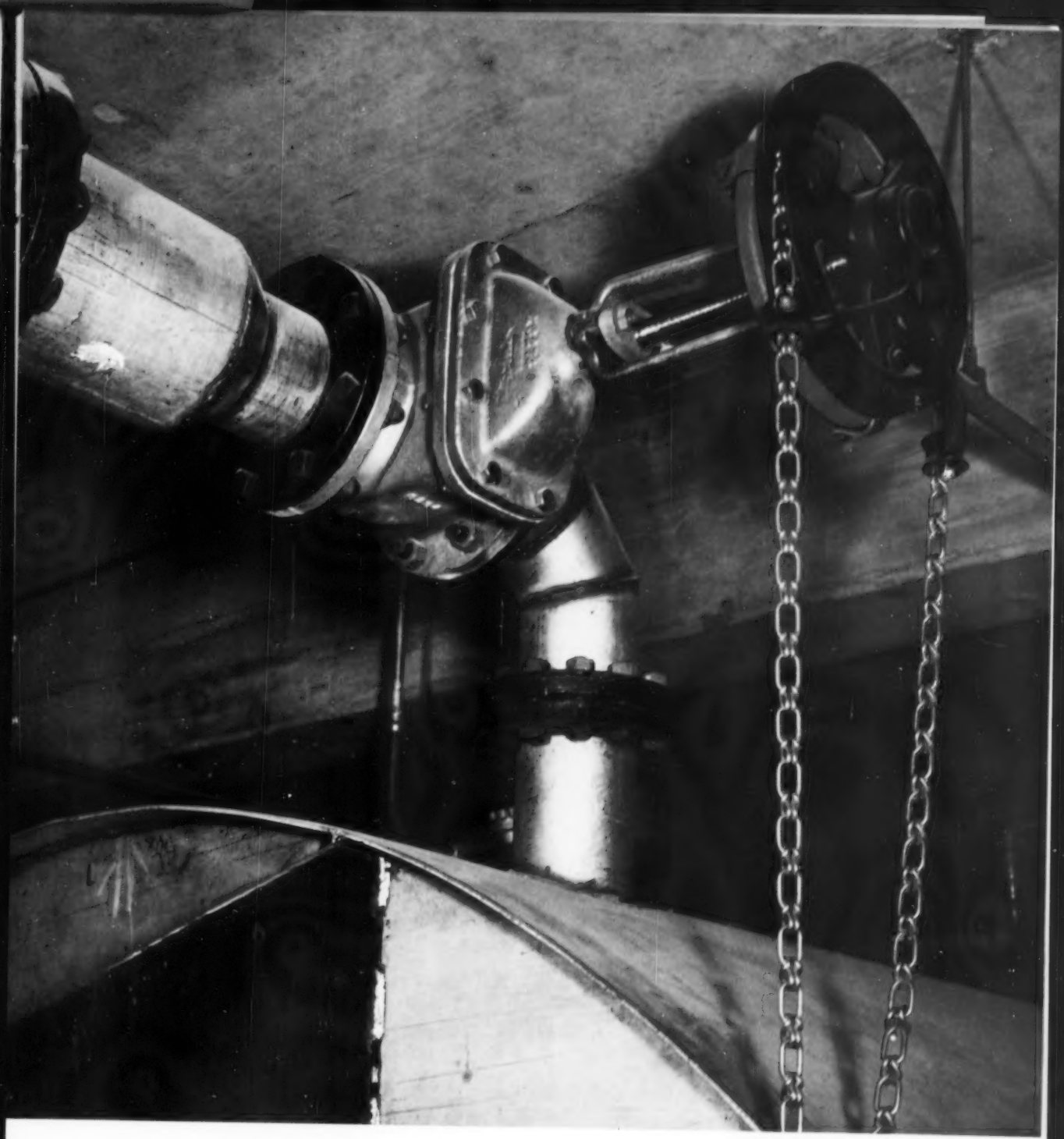


Film censor at work

At 950-acre Kodak Park, the film-producing plant of Eastman Kodak Co. in Rochester, N. Y., they take no chances on film contamination.

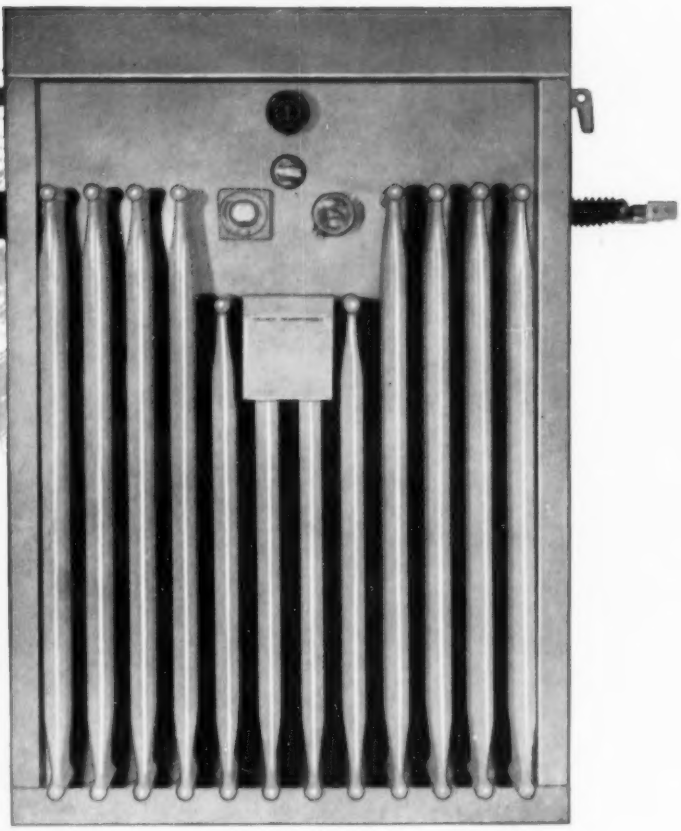
For example, in the operation shown here, a red-wheeled Aloyco stainless steel valve rules out of the picture dangerous rust and iron contaminants which would spoil the thick fluid which is called "dope." These valves control the flow of dope onto roll-coating wheels, where solvents are driven off with heat. The dry film base is then readied for the final coat of emulsion.

Today thousands of industrial processes are being safeguarded by Aloyco corrosion and contaminant-resistant valves. Find out why their dependable performance makes them first choice for all types of vital flow lines. Write Alloy Steel Products Co., Inc., 1301 West Elizabeth Avenue, Linden, N. J.

Longer Lasting
ALOYCO
VALVES
FIT IN CORROSIVE SERVICE

Subsidiary of Walworth Company

Wagner®
TRANSFORMERS
... the choice of leaders in industry



PLANNING A NEW LOAD CENTER?

...with the Wagner Close-Coupled Transformer, you can build a compact, modern unit substation

These Unit Substation Transformers save space... make a neat, streamlined installation

Wagner close-coupled, liquid-filled unit substation transformers can be easily flush-mounted with co-ordinated switchgear. And when they are, the result is a neat, modern, compact installation that not only saves space in your plant, but looks better too.

You get quicker delivery on a close-coupled Wagner transformer because there are fewer engineering difficulties than with the throat-connected type. It's not necessary to co-ordinate the bushing height of a close-coupled unit to match special switchgear. Bushing heights are designed to give ample room to make connection to switchgear or busses in the switchgear compartment or transition section. No need for special throats to match special switchgear.

Look to Wagner for transformers that assure a continuous dependable flow of power. Your nearby Wagner engineer will be glad to help you solve your load-center problems. Call the nearest of our 32 branch offices or write us.

Wagner Electric Corporation
6458 Plymouth Ave., St. Louis 14, Mo., U. S. A.

BRANCHES AND DISTRIBUTORS IN ALL PRINCIPAL CITIES

T36-4

ELECTRIC MOTORS • TRANSFORMERS • INDUSTRIAL BRAKES • AUTOMOTIVE BRAKE SYSTEMS-AIR AND HYDRAULIC

step with community custom or transportation facilities.

3. Labor sources
Employment in disregard of community make-up
Employment of new people in preference to furloughed people
Employment out of normal area

4. Applicant interviews
Long waits
Curt reception
Unsympathetic or indifferent attention
Mass interviews
'Smart aleck' attitudes

5. Employe introduction
No introduction to other employes
Short or indifferent reception by foreman
No explanation of the job or of regulations

6. Entering and leaving company premises
Too much arrogance by guards
Too much zeal in inspecting personal property
Too much red tape in entering or leaving

7. Sanitary facilities
Open door toilets
Communal bars of soap
No toweling
Unclean facilities

8. Attitudes
Talking down to employes
Too much stress on impersonal statistics
Too much 'you'

9. Disciplinary action
Public punishment
Partiality
Procrastination
Petty enforcements
Loud talk.

Employe relations is the working relationship between responsible representatives of management and the employes they supervise. It should not be lost sight of that the gang boss, the foreman and the supervisors are the key men. They build a company's internal public relations and unless their efforts construct a good foundation of co-operative employe relationships, the external public relations efforts of a company will be about as inaudible as a sigh in a gust of wind.

##

... make every step a safe step
BLAW-KNOX ELECTROFORGED®
STEEL GRATING and STAIR TREADS

On stair treads, walkways, catwalks, platforms and floors—both indoors and outdoors—you can provide safe walking conditions. For Blaw-Knox Electroforged Steel Grating brings you these exclusive features:

1. rigid one-piece construction—easy to install
2. non-slip twisted crossbar—for safe footing
3. three types of bearing bars
   - square bars—for smoothest walking surface
   - knurled bars (Furro-Grip)—for extra safety plus relatively smooth walking surface
   - serrated bars—for maximum safety under extremely hazardous skid conditions
4. no sharp corners to clog—self-cleaning
5. all surfaces accessible—easy to paint
6. maximum open area—for light and ventilation

Write for your copy of new Bulletin No. 2486
—or send dimensional sketch for quotation.

BLAW-KNOX
BLAW-KNOX COMPANY
BLAW-KNOX EQUIPMENT DIVISION
Pittsburgh 38, Pennsylvania

GRATING APPLICATIONS: floors • platforms • walkways • catwalks • stair treads • fan guards • shelving • and many other uses, both outdoors and indoors, for versatile steel grating

For more data on advertised products, use Readers' Service Cards, last page

He CAN NOT produce effectively.

He CAN produce effectively.

Are You Tense?

Here's how Ethyl Corporation increased the productiveness of its personnel by tension control.

EXCESSIVE TENSION limits the effectiveness of many men and women —though it often goes unrecognized.

With the cares and responsibilities of a job and a family in our accelerated and complex society, the career of the average businessman often is a living example of high tension. If he is successful, he usually is stimulated to greater achievements. If he is in difficulty, he often tries even harder to achieve security.

All during the day, everyone engages in a series of activities that involve the contraction of muscles throughout his body. If these muscles are maintained in a state of abnormal tone—tension—for any reason, the output of effort in the conduct of the day's work is correspondingly increased and may be excessive.

The fatigue that results from overstimulation sometimes is not apparent until many people find themselves in a state of general fatigue. Tensions built up during the day continue, and often the cares of business go home with them. If allowed to go unchecked, excessive tension can result in irritability, reduced efficiency, chronic fatigue and a number of other physical disorders. The ability to recognize excessive tension and control it, on the other hand can contribute to the productivity, health and happiness of the modern businessman.

Recognizing the importance of tension control to its employees in both their work and home life, Ethyl Corporation two years ago began to investigate the possibilities of doing something about it under its industrial relations program. Since that time, Ethyl, with gratifying results, has provided instruction in tension control for some of its executives and supervisory employes.

The method employed has been widely used for more than 35 years. It was developed by Dr. Edmund Jacobson, of Chicago. Since it was first introduced, the method has taught thousands of people how to operate their bodies so that they can enjoy calmer, happier, healthier and more profitable lives.

Other doctors and laymen have been trained in the successful use of Dr. Jacobson's methods, and he and these men have taught it to many men and women of various ages and occupations. In addition, U. S. Navy air schools have used the methods with good results in training more than 15,000 cadets.

People who have been helped by the methods endorse their use enthusiastically. The president of a nationally-known business concern says that after he undertook the training he achieved a degree of tension control he had never thought possible. The associate medical director of one of the country's largest insurance companies has said that he wished he could persuade the employes as well as the executives of his company to learn the techniques. "It would benefit them more than all the time they spend on the golf course and the bowling alley," he stated.

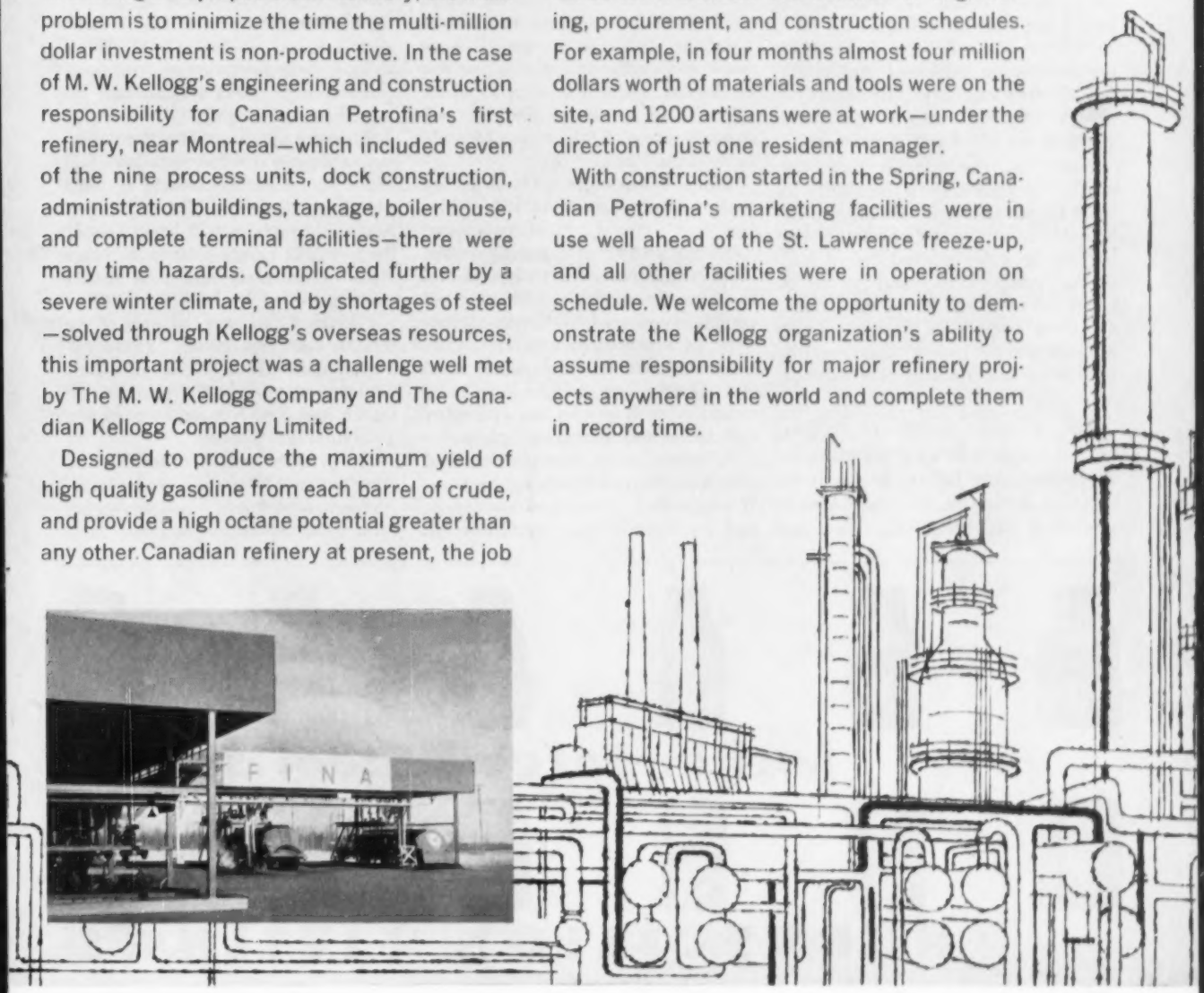
A high-ranking officer in the Navy tells of his experience: "Before World War II, I suffered a complete breakdown. My doctors told me I would

Helping Another Oil Refiner Grow —with Fewest Growing Pains

In building a major petroleum refinery, the main problem is to minimize the time the multi-million dollar investment is non-productive. In the case of M. W. Kellogg's engineering and construction responsibility for Canadian Petrofina's first refinery, near Montreal—which included seven of the nine process units, dock construction, administration buildings, tankage, boiler house, and complete terminal facilities—there were many time hazards. Complicated further by a severe winter climate, and by shortages of steel —solved through Kellogg's overseas resources, this important project was a challenge well met by The M. W. Kellogg Company and The Canadian Kellogg Company Limited.

Designed to produce the maximum yield of high quality gasoline from each barrel of crude, and provide a high octane potential greater than any other Canadian refinery at present, the job called for maximum coordination of engineering, procurement, and construction schedules. For example, in four months almost four million dollars worth of materials and tools were on the site, and 1200 artisans were at work—under the direction of just one resident manager.

With construction started in the Spring, Canadian Petrofina's marketing facilities were in use well ahead of the St. Lawrence freeze-up, and all other facilities were in operation on schedule. We welcome the opportunity to demonstrate the Kellogg organization's ability to assume responsibility for major refinery projects anywhere in the world and complete them in record time.



REFINERY PROCESS DIVISION

THE M. W. KELLOGG COMPANY

225 BROADWAY, NEW YORK 7, N. Y.

The Canadian Kellogg Company, Ltd., Toronto • Kellogg International Corporation, London

SUBSIDIARIES OF PULLMAN INCORPORATED

M KELLOGG W

have to retire and work at one-third speed for the rest of my life. But I learned of this method of easing tension and worked at it seriously. During the war, I was able to work 12 or 14 hours a day in Washington, board a plane for a long trip, turn myself out like a light, and get off at my destination refreshed and ready for another long day. The ability to achieve tension control not only changed my life, I feel it saved it."

Navy air cadets who took the course reported help in the ability to sleep longer and more soundly; to do better in academic and physical training; to be more relaxed before and during competitions; and to do a better job of flying. At the same time, the total number of days lost from injuries among cadets receiving the tension control training was reduced 38 percent.

The scientific system of tension control requires full participation in developing new habits, but if it is followed faithfully the step-by-step procedure can bring impressive results. The more exactly it is followed and the longer it is pursued, the more benefits it provides.

In approaching the subject, it is important to understand that tension control is achieved by gaining muscular control. When a businessman learns to relax all his muscles except those needed to perform the task at hand, he is able to accomplish more work and be less fatigued at the end of the day. He will be happier in his job and in his home life. He will sleep better and his entire life will be better.

Many businessmen, of course, are tense without realizing it. When their legs are crossed, their forehead wrinkled, sitting or standing stiffly, or when the muscles in their neck and shoulders are contracted, they are not completely relaxed. Similar small tensions, of which many men are totally unaware, constantly tighten the muscles all day long, building up pressures that lead to mistakes and other difficulties and increasing fatigue.

A review of a few physiological principles help explain why this is so. If a muscle is tense, it is contracted, and therefore it is in use. Even the slightest mental or bodily activity includes the contracting of some muscles. But muscle contraction also includes nerves. About half of the nerves in the body are used to alert the muscles or carry messages from the muscles to the brain. The activity of the nerves, electrical in nature, moves along the muscle like a wave, with a rapid discharge rate. When this discharge rate is greatly increased, there is high nerve tension and the muscle becomes rigid.

Since the nerves are in action whenever a muscle is tense, it follows that the relaxing of the muscle includes the easing of nerves. The relaxing of any set of muscles will begin to stop the spread of nervousness to the other areas of the body and thus restore calmness.

Practice is an essential part of the tension control methods. Those following them are urged to fix a particular time of day for practice. At least a half-hour is recommended and an hour is much better.

The practice consists of tensing and relaxing various muscles of the body. These manipulations teach you to become aware of tension, to recognize it

Hexagonal Swages and Bull Plugs • External Upset Swages and Sub-Tubing Nipples • Refinery Swaged Nipples and Bull Plugs • Seamless Casing Nipples • Seamless Tubing Nipples • Steel Tubing Couplings • Substitute Couplings • Sub-Tubing Nipples and Pup Joints • Perforated Tubing Nipples • Adaptor Nipples • Boiler Nipples • Choke Nipples.

LARKIN LEADERSHIP HAS BEEN EARNED

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whenever and wherever it occurs in your body, and to control it effectively. A large part of each practice session is also spent in complete relaxation.

Skill at tension control is put to a practical test, of course, in everyday activities. Differentiating between the muscles that must be tense to carry out necessary activities and those which are not needed and consequently should be relaxed, and relaxing them, is the goal.

Many people exert more muscular effort in their work than they need—they "try too hard." When they learn to ease up, they usually observe an increase in efficiency and a reduction in tiredness at the end of the day.

In its awareness of the importance of tension control to individual employes, Ethyl Corporation in 1953 examined Dr. Jacobson's methods. As a part of this investigation, which was headed by C. R. Holton, Ethyl's industrial relations director, ten of the company's top executives took Dr. Jacobson's course in tension control. The results were favorable and it was decided to make the program available to more Ethyl personnel.

Accordingly, Ethyl's manager of training was trained as a qualified instructor. Since then, he has conducted three ten-session courses in tension control for selected supervisory employes in Ethyl's New York offices.

The interest in these courses is evidenced by the answers to questionnaires sent to participants at the conclusion of each. Almost without exception, they reported beneficial results. The degree of skill in relaxation which they acquired varied considerably, depending upon natural ability to relax, which varies with individuals, and the amount of practice which each individual devoted to learning the subject.

Some reported that the mere ability to recognize tensions, which they had not realized existed before, was beneficial to them. Others reported ability to sleep more soundly, greater efficiency in their work, and some reported less friction and better relationships with others, both in their business activities and family life.

Although this was an abridged training program especially devised for Ethyl Corporation, its simplicity and ease are such that it can readily be extended. Just how far the program will be expanded in Ethyl Corporation is now under study.

Meanwhile, Ethyl's experimental program has created an interest in the subject of tension control among other companies. A nationally-known merchandising organization has engaged Dr. Jacobson to train one of its men as an instructor and has instituted its own program. A commercial airline is studying the possibility of giving tension control training to its pilots. Two leading oil companies have asked for fuller information on the subject with the thought of making it available to some of their employes. Inquiries have also been received from a number of other business and industrial firms.

Thus, it would appear American business is becoming aware of the importance and potential of successful tension control for its employes. As time goes on and scientific methods are applied by still more companies, it may well develop that they will have far-reaching effects in improving the business and personal life of large segments of the working population. ##

Nipples and Bull Plugs are

FROM START TO FINISH

There are 16 separate manufacturing and inspection operations that every Larkin Fitting undergoes before it leaves our plant. Beginning with the finest raw materials available, every step in the manufacturing process is designed to produce the finest precision fittings money can buy. After forging, Larkin Fittings receive careful descaling, threading, chamfering, beveling, coating, labeling and packaging. In between each operation is a step-by-step inspection. And there are no short-cuts. Specify Larkin through your supply store.

LARKIN PACKER COMPANY, INC.
WAXAHACHIE, TEXAS

LARKIN
...Through Your Supply Store

PESA

BY YEARS OF DEPENDABLE PERFORMANCE

For more data on advertised products, use Readers' Service Cards, last page.

What's Happening . . .

. . . in the Industry

On behalf of API, H. E. Hands, refinery manager for The Ohio Oil Company at Robinson, Ill., delivers an award to H. E. Burckhalter, laboratory supervisor.

. . . and to A. E. Slawson, barrel-house foreman. Together, the two awards mark the completion of more than a million man-hours without a disabling accident.

Write Offs Favor Small Companies

Rapid tax amortization has caused no great concentration of economic power in the petroleum industry. Instead, according to a report by the Justice Department, the issuing of write-off certificates has tended to favor smaller companies.

The report, made to Congress, shows that tax certificates were issued to the 20 major petroleum companies in a lesser ratio than their 1950 share of total production. This, it is pointed out, has favored the smaller companies and a competitive economy.

It was noted that the 20 companies refind 83.7 percent of the crude oil processed in the U. S. in 1950. This is the year the write-off program started. At the end of 1954, the same companies accounted for 82 percent of the crude processed, with the balance accounted for by all the other companies.

The large companies received fast tax write-offs on new emergency facilities be-

Ohio Refinery Gets Safety Nod

Running up a combined score of more than a million accident-free man-hours, two departments of The Ohio Oil Company's Robinson, Ill., refinery have received national recognition from the American Petroleum Institute.

Presented to the refinery laboratory and lube oil and grease warehouse, each API Accident Prevention Award was for over a half-million man-hours worked without a disabling accident.

Acting in behalf of the API, H. E. Handy, refinery manager, delivered the awards to Harley E. Burckhalter, laboratory supervisor, for 670,000 man-hours without a disabling accident, and to Arthur E. Slawson, lube oil and grease warehouse foreman, for 520,000 man-hours.

The refinery has received plaques from both the API and the National Safety Council for accident prevention. In 1950, the entire refinery was cited for 2,423,961 safe man-hours worked. In 1951, the Still Maintenance department received the API's million-man-hour award for 1,129,191 man hours. And the refinery Electrical shop was recognized in 1950 for going 19 years without a disabling accident.

During the past five years, Ohio Oil's Refining department has won three National Safety Council awards. They came in 1950, 1952 and 1954.

South Africa Selling Synthetic Gasoline

South Africa's state-owned SASOL has started selling gasoline from its $85-million oil-from-coal plant. The product, being sold to the public for the first time, has an octane rating of about 85.

The synthetic fuel is retailing at a little more than 1 cent a gallon less than imported gasoline. Imported gasoline is selling at 38.5 cents an Imperial gallon, or about 33 cents for a U. S. gallon.

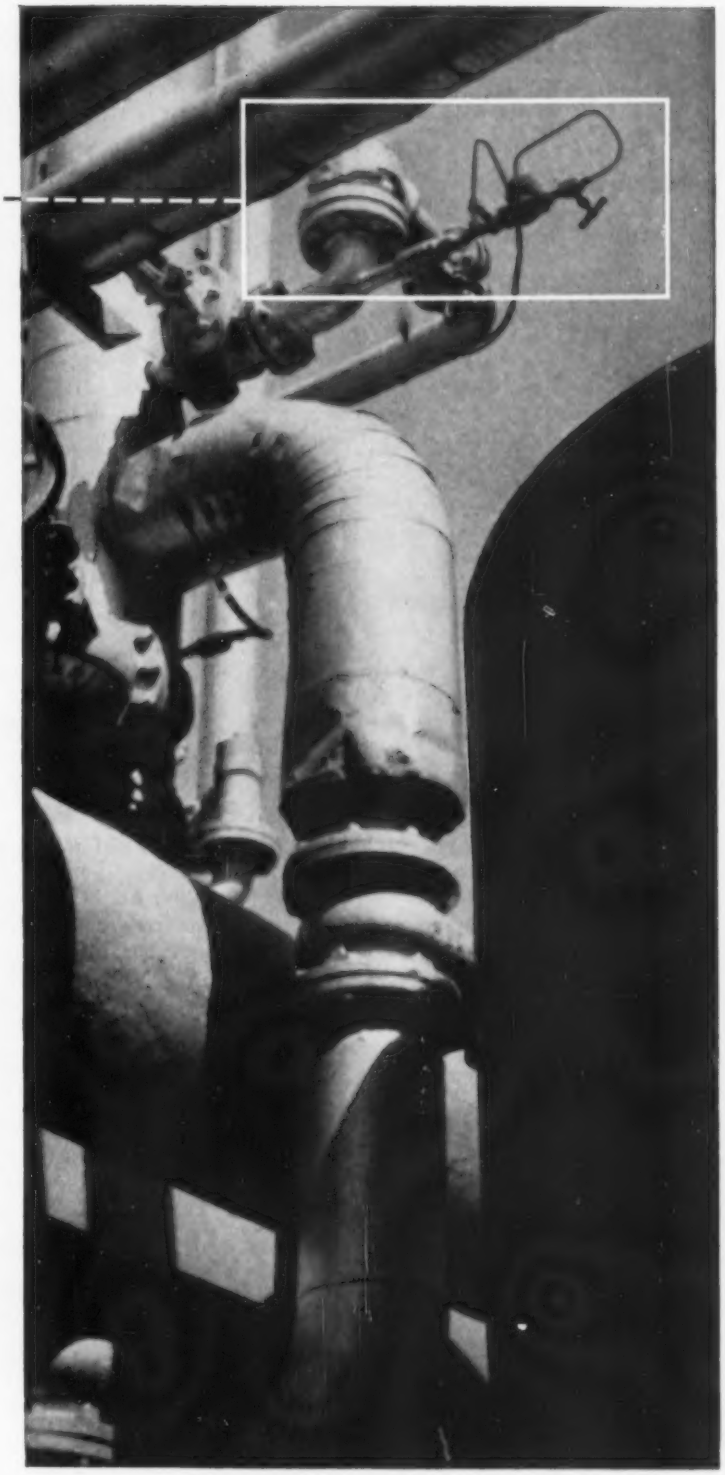
Workingman's Fashion Show

Here are the latest styles in shock helmets worn by construction workers at the site of Tide Water Asociated Oil Company's refinery going up near Wilmington, Del. About 25 separate crafts are working at the location, and each craft wears an identifying helmet.

A variety of colors, stripes, crosses and polka-dots bedeck their headgear. Boilermakers, for example, wear dark blue; millwrights sport pink with a white stripe, and safety men are conspicuous in yellow with an encircled cross in green. Above, a warehouse man tapes a black stripe on a white helmet to designate a concrete worker.

The construction scene is as colorful as a spring millinery show, but the helmets have their practical purposes. In addition to protecting workmen, they enable foremen to locate their men at a glance.

LIFELINE FOR A REFINERY



This thin loop of copper tubing is the mark of a refinery that has learned to combat corrosion and fouling the modern Polyrad way. This is the injection line for Polyrad—and it can well be called the "lifeline" for refinery equipment.

Polyrad is a filming amine that acts both as an inhibitor and detergent. Its detergency maintains throughput, increases heat transfer, and cuts down time for maintenance. At turn-around time you really see the difference—Polyrad—protected bundles are free of corrosion, ready for immediate return to service.

Stocks of Polyrad are maintained throughout the country. A Hercules trained representative will be glad to discuss its application to your specific operating conditions.

Pine Chemicals Division, Naval Stores Department
HERCULES POWDER COMPANY
INCORPORATED
976 Market Street, Wilmington 99, Del.

POLYRAD®
FILMING AMINE INHIBITOR

NASS-6

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A KERRIGAN
Grating for Every Need
A CATALOG
for every Grating

Write for your
Copy NOW!

STEEL
for the 1001 applications where safety and strength come first. Kerrigan Steel Grating is BONDERIZED for corrosion resistance and extra years of life.

STAINLESS and MONEL
non-magnetic steel for the chemical, oil and packing industries . . . for ANY installation where high resistance to heat, acids, chemicals, and corrosion is needed.

TRULY . . .
In both size and type, there is a Kerrigan Weldforged grating for every need. Let our new catalogs prove it to you. Send for the one you think best answers your need (or ask for ALL FOUR if you wish). We will also be glad to send you a desk-size grating sample. Write Kerrigan Iron Works, Inc., General Sales Office, 274 Madison Ave., New York City.

RIVETED STEEL
where it is desired to match existing grating.

ALUMINUM
spark-proof for those whose need is strength AND lightness. Extra safe and strong. Allowable fiber stress 15,000 psi. Modulus of elasticity 10,000,000 psi.

KERRIGAN GRATING
CUSTOM-MADE FOR YOUR JOB AND SAFE—IT'S Weldforged

What's Happening . . .

tween 1951 and 1955 on a lesser ratio. Facilities certified for the 20 companies during that period were for on an estimated cost of $2.7 billion. This is about 72.7 percent of the total amount certified under the program.

Conoco Purchases Petrochemical Firm

Continental Oil Company has purchased the capital stock of the Sherwood Refining Company, Englewood, N. J., manufacturers of industrial chemicals. Sherwood Refining, with plants at Gretna, La., and Karns City, Pa., is a leading producer of natural sulfonates, white oils and petrolatum, all derived from refinery petroleum stocks.

The present Sherwood management will continue to operate the business. Conoco operates petrochemical plants at Chicago, Baltimore and Trainer, Pa.; owns an interest in four carbon black plants in the Southwest, and is co-owner of a butadiene rubber plant at Lake Charles, La.

Chemicals Wanted

The National Registry of Rare Chemicals, Armour Research Foundation of Illinois Institute of Technology, 33rd, Federal and Dearborn Streets, Chicago 16, has received urgent requests for the chemicals listed below. If anyone has one or more, even if only one gram quantities, please inform the Registry.

2,6-Diaminonaphthalene-3-sulfonic acid
2,6-Dibromonaphthalene-3-sulfonic acid
Ethyl fluoride
Pentafluorophenol
Perfluorocyclopentane
Perfluorocyclohexane
Perfluorocycloheptane
Resorcinol-4,6-disulfonic acid
tert-Butylmethyl ether
1,2-Butanediol
9-Bromo-2-nitrofluorene
p-tert-Butylbenzaldehyde
3-Cyclohexene carboxylic acid
2-Chlorobutanol-1
1-Chloro-2,4-dinitronaphthalene
3-Chloro-1-butene
1,7-Dimethylphenanthrene
Dihydro isoindole
4-Hydroxyphenylethanol
India paraffin

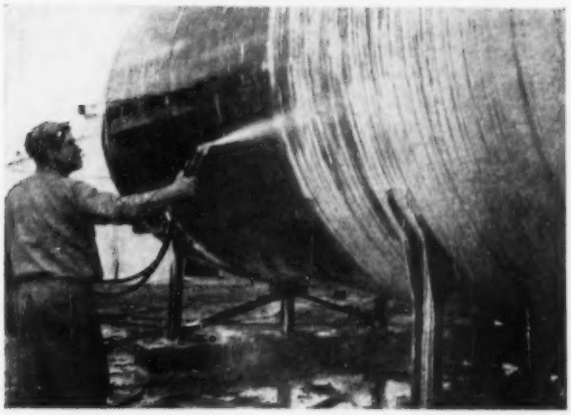
World Refining Output Down in May 1955

Total world production of major refined products averaged 12,370,000 barrels a day in May 1955, as compared to 12,363,000 barrels a day during April. This is the report of the Bureau of Mines. It does not include the output of Communist countries.

World crude runs to the stills averaged 13,140,000 barrels a day during May, showing a decrease of .7 percent from April.

Runs in the Netherlands Antilles were 705,000 barrels a day, and in Venezuela they were 475,000 barrels a day. Both figures represent a decline from April. Runs in the United Kingdom averaged 533,000

How to strip a storage tank

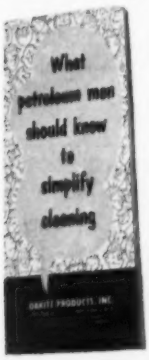


without scraping or sandblasting

BUT FAST—that's how old coats of paint roll off when you strip tanks the quick, money-saving Oakite way.

Powerful Oakite strippers, applied by hot-flow-on, steam-gun, or cold-flow-on method, actually float off paint, dirt, and grease—right down to the base metal. You save time . . . no hand scraping, chipping or blasting. You save money . . . long-life solution may be reclaimed and reused, And you're safe . . . no fire hazard.

Ask your local Oakite Technical Service Representative for on-the-spot demonstration. Or write Oakite Products, Inc., 50B Rector Street, New York 6, N. Y.



FREE Booklet F7629—full of information on maintenance cleaning in all divisions of the Petroleum Industry—describes proved, money-saving Oakite procedures for such jobs as

- cleaning stabilizing towers
- cleaning tank car interiors
- descaling heat exchangers in place
- reconditioning barrels
- salvaging rigs, valves, fittings

Copy sent on request. Write today!

SPECIALIZED INDUSTRIAL CLEANING

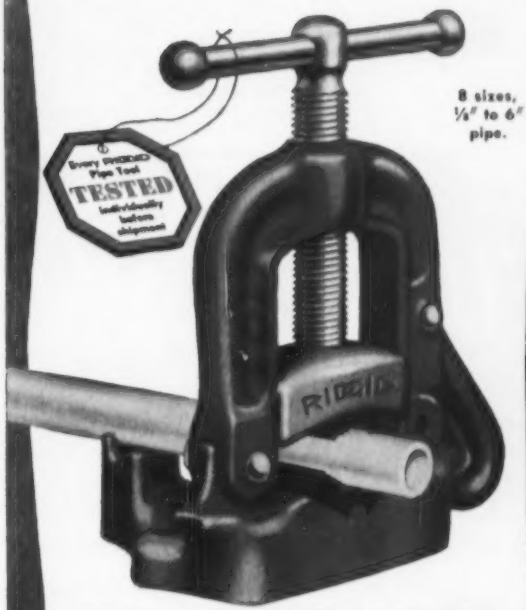
OAKITE

MATERIALS · METHODS · SERVICE

SCIENCE

Technical Service Representatives in Principal Cities of Canada

Extra-Handy ...and tough all the way through!



RIDGID

the easy-to-use Bench Pipe Vise

Look at the *more* you get for your money . . . built-in pipe rest aids accurate threading, handy pipe bender . . . Lon-Grip tool-steel jaws hold pipe firmly without chewing it up . . . yoke and base of special last-a-lifetime malleable . . . a bargain in quality!

Order from your Supply House today.

RIDGID Chain Bench Pipe Vise —5 sizes to 8" pipe.

RIDGID

Work-Saver Pipe Tools

The Ridge Tool Company, Elyria, Ohio, U.S.A.

For more data on advertised products, use Readers' Service Cards, last page.

What's Happening. . .

barrels a day, down 4.8 percent.

Production of motor fuel was 5,140,000 barrels a day in May, against 5,029,000 barrels in April. Kerosine production was 729,000 barrels, compared to 735,000 barrels in April. And distillate fuel oil was turned out at the rate of 2,676,000 barrels a day in May, and at 2,672,000 barrels a day in April.

Residual fuel oil averaged 3,606,000 barrels a day in May, and 3,702,000 barrels a day in April. May production of lubricants averaged 219,000 barrels a day, as compared to an output of 225,000 barrels a day in April. World crude stocks during May decreased 34,000 barrels a day.

Atoms No Threat To Oil-Gas Industry

Atomic power will offer the oil and gas industry no serious competition, according to one prominent member of the industry. In the report of an advisory panel appointed by the Congressional Joint Committee on Atomic Energy, Wallace E. Pratt said that inroads of atomic energy into the industry will be trifling.

Pointing out that fuel oil demands account for only 3 percent of the domestic market and that demand for residual oil already is on the decline, Pratt said the oil industry is not worried about the advent of the new power source.

Although the gas industry might feel the effects of atomic heat more than oil, Pratt said the effect still will be small. Electric utilities now consume 13 percent of the gas marketed, and the probability is that rates might be reduced to meet the competition.

Goodyear to Back Interest in Science

Goodyear Tire & Rubber Company has set up a four-point program designed to stimulate interest and encourage greater participaton in scientific careers. The one-year program includes:

- Advanced technical training for high-school mathematics and science teachers in one Ohio county.
- Increased enrollment and facilities for the company's apprentice school.
- Expanded activities in the company-sponsored Engineering Squadron training program.
- Financial aid to the education of Goodyear personnel engaged in engineering and technical work.

Sixteen teachers will be selected from Summitt County to participate in the teacher-phase of the program. Some two-thirds of those selected will be given scholarships for summer-school advanced training. The others will be placed in jobs at the Akron plants.

Enrollment and facilities of the apprentice school and Engineering Squadron will be increased, with the company paying the tuition of any fourth-year apprentice or trainee who will study engineering in his off-hours at any of the nearby universities.

A similar program will be started for college graduates who are engaged in technical or engineering work for the company, and want to pursue advanced studies.

Copies of Index Still Available

Copies of the 1955 PETROLEUM REFINER Index, which in the past always has appeared in the December issue, are still available to subscribers—now upon request. Readers who want this valuable guide to the past year's advancements in refining, petrochemicals and natural gasoline should use the Reader's Service green card in the back of this issue. Write on the card, "1955 PETROLEUM REFINER Index," fill in name, address and mail. There is no charge or obligation.

Premium Octane Ratings Climbs to 96.4 Average

Gasoline on sale at service stations in February showed a national weighted average of 96.4 octane number for premium and 89.2 octane number for regular, according to the monthly survey of Ethyl Corporation.

The premium gasoline average was 0.2 octane number higher than in January and 1.6 octane number higher than in Febuary, 1955. The regular gasoline average was unchanged from January but 1.8 octane number higher than a year ago.

Average tetraethyl lead contents in February were 2.47 ml per gallon of

TC
CUPRIC CHLORIDE
PRODUCED BY THE
TENNESSEE CORPORATION
MINERS OF COPPER, ZINC, IRON AND SULFUR.

For Removal of Sulfur Compounds in Petroleum Refining.

CUPRIC CHLORIDE DI-HYDRATE
TC TENNESSEE CORPORATION

CONTRACT REQUIREMENTS SOLICITED . . .
We are in a position to supply your needs on annual, semi-annual, or monthly contract basis—also smaller quantities in drop shipment lots.

TYPICAL ANALYSIS

Copper	37.00% Minimum
Moisture	12.00% Maximum
Fe	.04% Maximum
Zn	.01% Maximum
Water Soluble	more than 99.50%
Insoluble as copper oxychloride	less than .50%

CHECK THESE FEATURES:

√	HIGHER COPPER CONTENT
√	LOWER MOISTURE
√	FINER PARTICLE SIZE
√	UNIFORMITY
√	AVAILABILITY

FOR
1. Quality Improvement
2. Cost Reduction

Other Tennessee Corporation products, Ferric Sulfate (Ferri-Floc), Copper Sulfate, and Sulfur-Dioxide.

For Samples . . . Make request on your company letterhead.

TENNESSEE TC CORPORATION
617-29 Grant Building, Atlanta, Georgia

Tuffy® SLING NEWS

Vol. 1 Published Monthly in Leading American Trade Magazines by Union Wire Rope Corp. No. 5

NEW FERRULE TEAMS UP WITH Tuffy® FABRIC FOR BETTER SLINGS

Strength of Machine Braided Fabric Equaled in Eye-Splice

SPEEDS UP SLING WORK

See for yourself at your Tuffy distributor's how this new, steel ferrule on all Tuffy Slings is streamlined with no rough edges to injure hands or catch on loads.

The new ferrule on all Tuffy 9-part machine braided wire fabric slings is the most important development in slings since Tuffy made history by introducing machine braided wire fabric. Here's why:

1. This new ferrule, squeezed around the tucked eye splice of Tuffy Slings, under pressure, creates a force of friction so powerful that a pulled out splice is virtually a thing of the past.
2. Because the ends of the ferrule are swaged flush with the machine braided strands, there are no projections left to snag on loads or injure hands. As a result, handlers can work much faster and with greater safety—doing more in a shorter time—when they're working with flexible, Tuffy Slings.

3. You pay nothing extra. The new Tuffy eye-splice with pressed on metal ferrule gives you a far better Tuffy Sling—but at the same reasonable price.

As always, Tuffy Slings are extra flexible and kink-resistant. It's almost impossible to kink a Tuffy. But if it does kink, you can always straighten it without materially damaging the fabric. Everyone who has used the new all-metal pressed on ferrule agrees that it adds a great deal to the service life of Tuffy machine braided wire fabric slings.

Your Tuffy Distributor Can Save You Money

Tell him what your future requirements in Tuffy Slings and Tuffy Hoist Lines are likely to be. He'll tailor his stock for you to draw against. You'll save the time, space, and cost of maintaining your own inventory.

FACTS ON FERRULE, SLINGS, FITTINGS, IN FREE NEW TUFFY SLING HANDBOOK

This new 60-page Sling Handbook gives you complete information (charts and rated working loads) on a larger line of factory-fitted slings. It tells you how to use versatile Tuffy Slings on dozens of different jobs. It shows you how the new Tuffy metal ferrule is pressed on the eye splice to make Tuffy machine braided wire slings safer and faster to work, and it shows you the most advanced sling fittings available. On top of all this, it contains a brand new engineer's handbook and a valuable rigger's manual.

If you buy, use or specify slings—if you are concerned with shop safety, efficiency, and long service life—you need this fully illustrated, comprehensive Tuffy Sling Handbook. Mail the coupon to us now for your copy of the new edition. No obligation.

union Wire Rope corporation

Specialists in high carbon wire, wire rope, braided wire fabric, stress relieved wire and strand.

2284 Manchester Avenue, Kansas City 26, Missouri

MY NAME _____ TITLE _____

COMPANY NAME _____

ADDRESS _____

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For more data on advertised products, use Readers' Service Cards, last page.

THERMAL'S

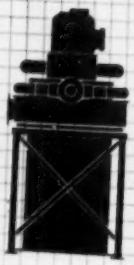
COMPACT FIRED

HEAT EXCHANGERS

CAN SOLVE YOUR

HEAT TRANSFER

PROBLEM . . .



PRESSURE: 300 PSIG

TEMPERATURE: 1200 F

CAPACITIES: 750,000 TO 8,000,000 BTU/HR

TYPE DF for high pressure, high temperature applications.

PRESSURE: 50 PSIG

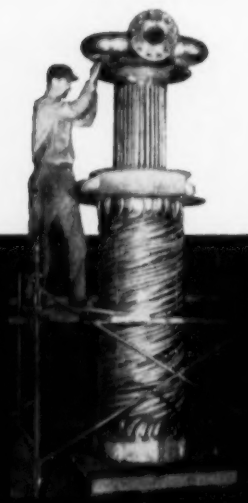
TEMPERATURE: 1000 F

CAPACITIES: 250,000 TO 1,500,000 BTU/HR

TYPE FT for medium pressure and temperature applications.

Unique THERMAL Burners make these heat exchangers possible —

Whether it be an existing standard design or a unit for your special requirements, THERMAL heat exchangers provide the ultimate in compactness, high performance and response. Always designed around the high velocity combustion characteristics of THERMAL burners, they are supplied as complete "package" installations including all control and accessory equipment.



TO YOUR SPECIFICATIONS

Send us your requirements. Our engineers will make a prompt analysis.

ECONOMICAL, TROUBLE-FREE DESIGN...

Both the type DF and FT THERMAL Heat Exchangers use a coiled tube design feature to allow for expansion. The clear flame characteristic of the THERMAL Burner makes convection the primary heat transfer means and thus promotes uniform metal temperature and long life.

OTHER THERMAL PRODUCTS & SERVICES . . . . . GAS & OIL BURNERS • COMBINATION GAS-OIL BURNERS • HEAT EXCHANGERS • AIR HEATERS • SUBMERGED COMBUSTION • COMBUSTION & HEAT TRANSFER ENGINEERING

THERMAL

Thermal Research & Engineering Corp.

CONSHOHOCKEN • PENNSYLVANIA

REPRESENTATIVES IN PRINCIPAL CITIES

What's Happening . . .

premium gasoline and 2.19 ml. per gallon of regular gasoline.

Thirty-five of the 53 cities covered by Ethyl's survey reported increases over January in the average octane number of their premium gasoline, with ten cities showing a monthly gain of 0.5 octane number or more. Eight cities reported decreases while ten cities were unchanged.

In regular gasoline, 28 cities reported increases in their average antiknock quality, six of them by 0.5 octane number or more. Twenty cities showed a decrease from January while five cities were unchanged.

Compared with the nationwide premium average of 96.4 octane number, 16 cities reported premium averages of 97 octane number or higher. In regular gasoline, 15 cities showed average octane ratings of 90 octane number or higher, compared with the national weighted average of 89.2 octane number.

Power Company Plans Smog-Control Program

Southern California Edison Company will spend as much as $1.75 million to develop means of controlling smog-contributing effluents from its steam generating facilities in Los Angeles County. The five-step program will be as follows:

- Study of methods to remove sulfur from fuel oils.
- Pilot installations of equipment to remove particulate matter and sulfur gases from stack effluent.
- Study of natural-gas and fuel-oil combustion toward minimizing smog effects.
- Employment of expert consultants.
- Selection of new plant sites in relation to air pollution.

The company will spend $250,000 on research and pilot installations in 1956, with another $1.5 million budgeted for next year if initial findings warrant the expenditure.

Tide Water Associated Sells Bayonne Property

Tide Water Associated Oil Company has sold its Bayonne, N. J., refining properties. They went to Bayonne Industries, Inc.

The holdings, at Bayonne and Jersey City, cover some 236 acres and include numerous buildings and improvements and waterfront facilities. They will be divided into smaller units and used by various new industries in the area.

Meanwhile, demolition work, which started late in 1955, is still underway on refining units and manufacturing facilities, which one time produced 80,000 barrels of petroleum products a day.

Tide Water announced its plans in 1954 to close the Bayonne refinery and supplant it with a new 130,000-barrel-a-day plant near Wilmington, Del. The Delaware refinery is due for completion late in 1956.

Phillips Employes Set Safety Record

Employes at Phillips Chemical Company's plants near Pasadena, Texas, have completed 2 million man hours of work without a disabling injury.

The record began in January 1955 and is the first such record established since

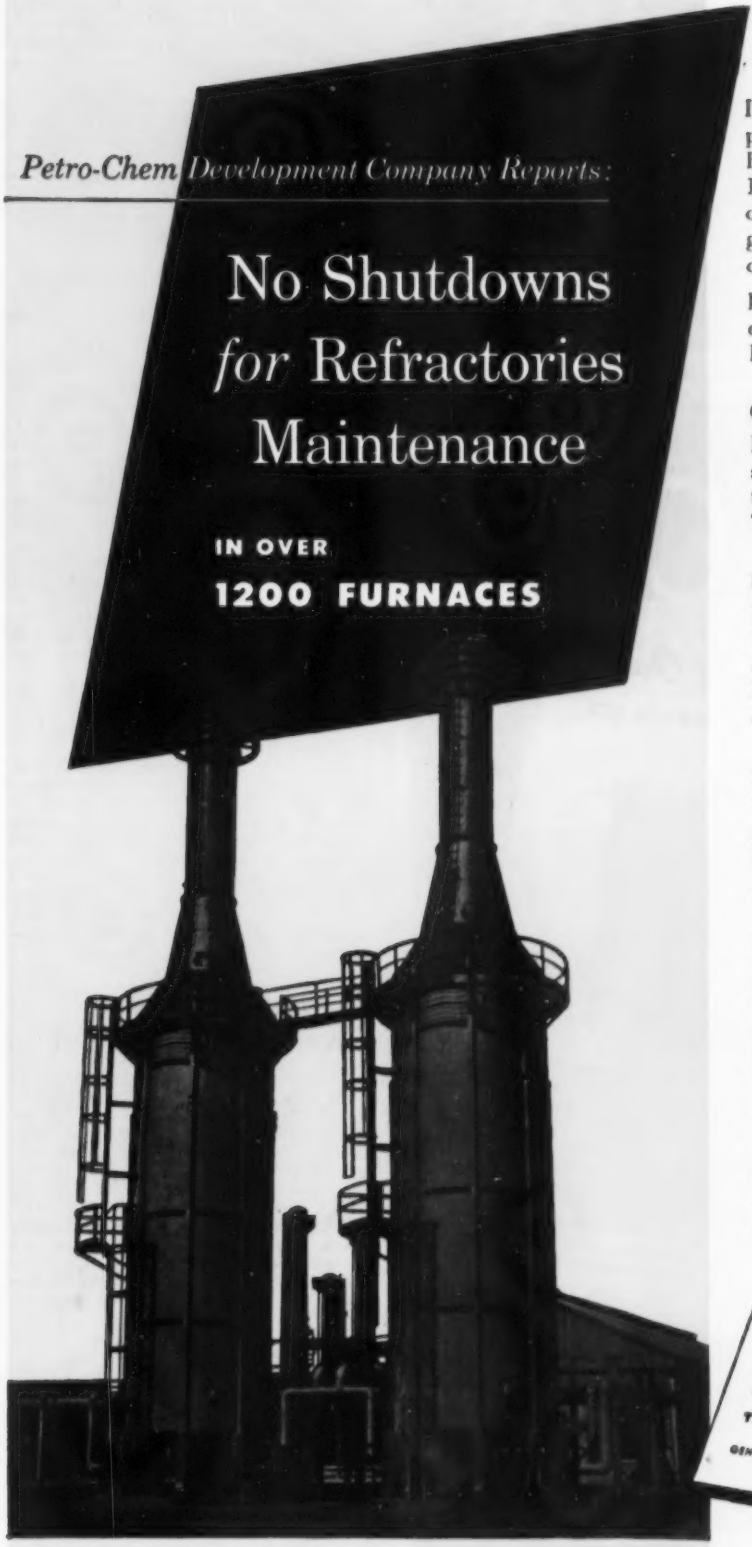
For more data on advertised products, use Readers' Service Cards, last page.

Petro-Chem Development Company Reports:

No Shutdowns *for* Refractories Maintenance

IN OVER

1200 FURNACES



In 1940, the Petro-Chem Development Company lined their first Iso-Flow furnace with B&W Insulating Firebrick. Today, over 1200 installations later, (some with fluid outlet temperatures over 1600F) not a single furnace has ever been shut down because of the need for refractory maintenance.

Long life is just one reason furnace builders, as well as furnace operators, insist on B&W IFB. Here are four more:

CUT INSTALLATION COSTS

B&W Insulating Firebrick are easy to install. They can be cut, drilled or shaped on the job with ordinary woodworking tools. Their lightness makes them easy to handle.

ELIMINATE EXPENSIVE ALLOYS

Because of their high insulating values, B&W Insulating Firebrick can be supported or anchored with ordinary carbon steel. Expensive, heat-resisting alloys are not necessary.

REDUCE DOWN-TIME

These brick have low heat storage, cool off quickly. This makes possible quick access to the furnace for inspection. They heat up quickly to get back on the line, too.

CLOSE TEMPERATURE CONTROL

Due to the low heat-storage capacity of B&W IFB, their hot-face temperature responds quickly to changes in the rate of heat input to the furnace — insuring the closest possible temperature control.

You, too, can profit by this four-way economy of B&W Insulating Firebrick. Ask your B&W representative for all the facts on these cost-cutting refractories. He'll be glad to discuss your refractory problems with you.

BABCOCK & WILCOX

THE BABCOCK & WILCOX CO.
REFRACTORIES DIVISION
GENERAL OFFICES: 161 EAST 42nd ST., NEW YORK 17, N.Y.
WORKS: AUGUSTA, GA.

B&W REFRACTORIES PRODUCTS — B&W Allmul Firebrick • B&W 80 Firebrick • B&W Junior Firebrick • B&W Insulating Firebrick B&W Refractory Castables, Plastics and Mortars • OTHER B&W PRODUCTS — Stationary & Marine Boilers and Component Equipment... Chemical Recovery Units . . . Seamless & Welded Tubes . . . Pulverizers . . . Fuel Burning Equipment . . . Pressure Vessels . . . Alloy Castings

For more data on advertised products, use Readers' Service Cards, last page.

What's Happening . . .

the Phillips Petroleum Company subsidiary began its operations in the Pasadena area in 1949, although a 1-million manhour record was completed in 1953.

Middle East Crudes Yield 97-Octane

The highest commercial octane numbers ever achieved from a straight-run Middle East naphtha were recorded during a test run in a new Ultraforming unit at the Montreal refinery of Canadian Petrofina, Ltd.

Starting with a feed of 40 octane number, the 3600-barrel-a-day unit produced a C_5-plus product with octane numbers as high as 97, research clear. The object of the test was to demonstrate prolonged performance at 93-octane.

After nine days at 93-octane, product quality was carried higher to test the unit's flexibility. Feed was the full boiling range naphtha from Kuwait crude.

Because Middle East stocks contain a high percentage of paraffins, they are among the most difficult naphtha to upgrade. Naphthas containing a higher percentage of naphthenes are being reformed to 100-octane clear by Ultraforming.

At American Oil Company's Texas City, Texas, refinery a 21,000-barrel-a-day Ultraformer which has been in operation more than a year is producing 100-octane clear reformate from Gulf Coast naphtha. Since it went into operation, the unit's catlyst has undergone more than 50 complete regeneration cycles.

An important advantage of Ultraforming is that catlyst activity can be restored by regeneration while the unit is in operation. In contrast to non-regenerative reforming processes, Ultraforming runs of short duration provide operating data which may be projected well into the future.

ARCCO
The World Over
wherever there is gas
ARCCO-ANUBIS
'Dry-Air GAS
GRAVITOMETERS
This new Arcco-Anubis Dry Air Gas Gravitometer determines and records specific gravity of gases automatically corrected to the humidity content of the air. The difference in weight between a column of GAS and equal column of DRY AIR is measured. This ratio represents the true specific gravity of the sample.
One bell of the instrument is filled with gas which is being measured, and the other bell is filled with dry air. Otherwise, except for the new instrument having one column for gas and one column for dry air, the unit is identical in operation to the standard gas gravitometer. When calibrated and properly installed, these instruments require little attention other than to wind the clock, ink the pen, and change the chart. Send for bulletin No. 101.
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RECORDING CHART CO.
3113 E. 11th St. • Los Angeles 23, Calif.
Available for Early Delivery
Send For Bulletin No. 101 R-2

Jersey Standard Spending To Be Based on New Process

Standard Oil Company (New Jersey) affiliates are planning to invest some $60 million in a new petroleum-refining process.

To be known as "Powerforming," the process features a new type catalyst which uses a relatively small quantity of plantinum. The process was known as "Platinum Reforming."

Two of the units are in operation and 14 others are either planned or under construction.

Those in operation are at the Imperial Oil, Ltd., refinery in Edmonton, Alta., and at Esso Standard Oil Company's Baltimore refinery. They are more than a year old. The other units are planned for both affiliated and non-affiliated companies.

The process was developed by Esso Research and Engineering Company. Basic work on the process started more than five years ago.

Pilot-plant tests at the research company's Linden, N. J., laboratories showed the new reforming catalyst constantly maintained its ability to cause the desired reforming reactions because of a new cleansing technique which preserves the catalyst for indefinite re-use.

It is estimated the petroleum industry has invested $700 million in catalystic-reforming plants over the past several years.

Goodrich-Gulf Buys Government's Last Plant

The government's last synthetic-rubber plant was sold to Goodrich-Gulf Chemicals, Inc. The plant, at Institute, W. Va., was sold for $11 million—$6 million more than its book value. Annual capacity is about 122,000 long tons.

The company is owned half by The B. F. Goodrich Company and half by Gulf Oil Corporation. One of the companies which acquired government-owned synthetic-rubber plants in 1955, Goodrich-Gulf bought the plant at Port Neches, Texas.

Sets Record Budget

Standard Oil Company of California expects to spend about $90 million in 1956 for expanding its refinery operations. The expenditure will be part of a record $350 million budget.

Smog-Control Law Sought for Cars

Los Angeles County has asked the governor of California to back a move to give local air-pollution districts authority to require smog-control equipment on automo-

For more data on advertised products, use Readers' Service Cards, last page.

How we S-T-R-E-T-C-H valve life

Every Powell Valve comes with a long, dependable life built-in. We make certain that every Powell Valve will give long, trouble-free service through careful quality control of every step of manufacture.

Quality control begins with the very materials and metals of which Powell Valves are made. For instance, the tensile strength test—stretching metal to the breaking point—is one of the numerous ways that *Powell Valves have Performance Verified.*

As a final step in manufacture, every Powell Valve is subjected to *an actual line test.* Because of Powell's painstaking quality control, plant shutdown through valve failure is greatly reduced. Records from refineries, power and industrial plants the world over prove it.

Consult your Powell Valve distributor. If none is near you, we'll be pleased to tell you about our COMPLETE *quality line* which has PERFORMANCE VERIFIED.

The Wm. Powell Company

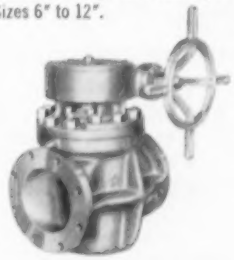
Cincinnati 22, Ohio . . . 110th YEAR

PERFORMANCE PV VERIFIED

FIG. 3003—Steel Gate Valve For 300 Pounds W.S.P.

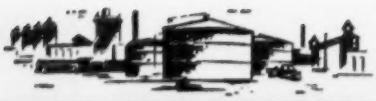
FIG. 375—Bronze "White Star" Gate Valve For 200 Pounds W.S.P.

FIG. 3059G—300-Pound Steel Lubricated Plug Valve Gear Operated. Sizes 6" to 12".



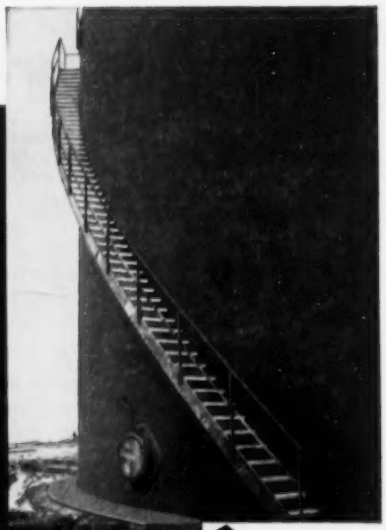
POWELL VALVES

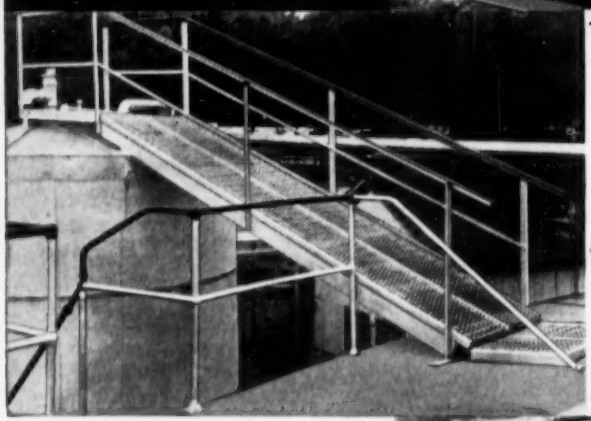
BRONZE, IRON, STEEL AND CORROSION RESISTANT VALVES.



Use SAFETY GRIP-STRUT grating

Wherever a safe footing is required





Grip-Strut circular stairway on Shell Oil tank in Portland, Ore.

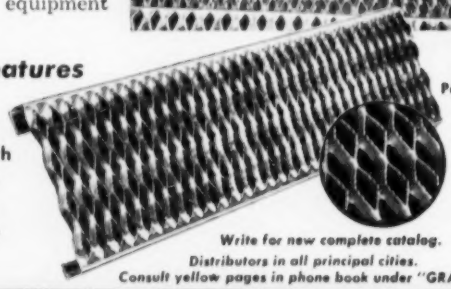
See how Shell Oil uses Grip-Strut for a safe ramp between tanks.

View looking down circular stairway on Shell Oil tank shown above.

SAFETY GRIP-STRUT is the new basic material, all in one piece (including channels), not welded, riveted or expanded in steel or aluminum, in standard sizes and gauges. Safety GRIP-STRUT presents an open space, in a diamond pattern, in excess of 55% of the area for ready access of light and air and gives a positive NON-SKID footing in all directions. Ideal for work platforms, stair and ladder steps, flooring, balconies, catwalks, machinery guards, fire escapes and for original equipment safety treads.

Important Safety Features

- ★ Fire proof
- ★ Slip proof
- ★ Maximum strength
- ★ Minimum weight
- ★ Easy to stand on
- ★ Cool in summer—warm in winter



Pat. Pending

Write for new complete catalog.
Distributors in all principal cities.
Consult yellow pages in phone book under "GRATING"

GRIP-STRUT division
THE GLOBE COMPANY • *Manufacturers since 1914*
4008 S. PRINCETON AVE. • CHICAGO 9, ILL.

What's Happening . . .

biles. The county board of supervisors asked the governor to submit such a proposal to the legislature at its next session.

The request is one of several smog-control proposals authorized by the supervisors for submission to the legislature. One of these is a proposal for industral zoning for minimal smog hazards.

Socony Mobil Backs Study at Rensselaer

Socony Mobil Laboratories has made a grant of $5000 to Rensselaer Polytechnic Institute, for the study of structure and flow properties of lubricating greases. The investigation will be made by Dr. Walter H. Bauer and Dr. Stephen Wiberley, both of the institute's Department of Chemistry.

Funds for the grant were made available through membership of Socony Mobil Laboratories in the continuing organization of Research Associates of the institute.

Copies of Index Still Available

Copies of the 1955 PETROLEUM REFINER Index, which in the past always has appeared in the December issue, are still available to subscribers—now upon request. Readers who want this valuable guide to the past year's advancements in refining, petrochemicals and natural gasoline should use the Reader's Service green card in the back of this issue. Write on the card, "1955 PETROLEUM REFINER Index," fill in name, address and mail. There is no charge or obligation.

Capacity Increase Predicted for 1956

World refining capacity is expected to total more than 18 million barrels a day by the end of 1956. At present, 66 countries have at least one refinery, and the total capacity of these is almost 17 million barrels a day, including an estimated 1,440,650 barrels in Communist countries.

The world has some 734 refineries, of which 341 are in operation in the U. S. and about 96 are in Communist countries.

In the past ten years, U. S. refiners have increased their basic capacity about 65 percent, reaching a combined operable capacity of 8,399,700 barrels a day. The country's basic-refining capacity is expected to increase about 200,000 barrels a day in 1956.

New Unit to Handle Defense Petroleum

Defense Department is due to set up a single unit to handle all petroleum logistics. The new agency, headed by an executive director under the Navy Department, will be in charge of all military petroleum planning and purchasing.

Under the plan, initial requisitions will be made by individual services. The man-

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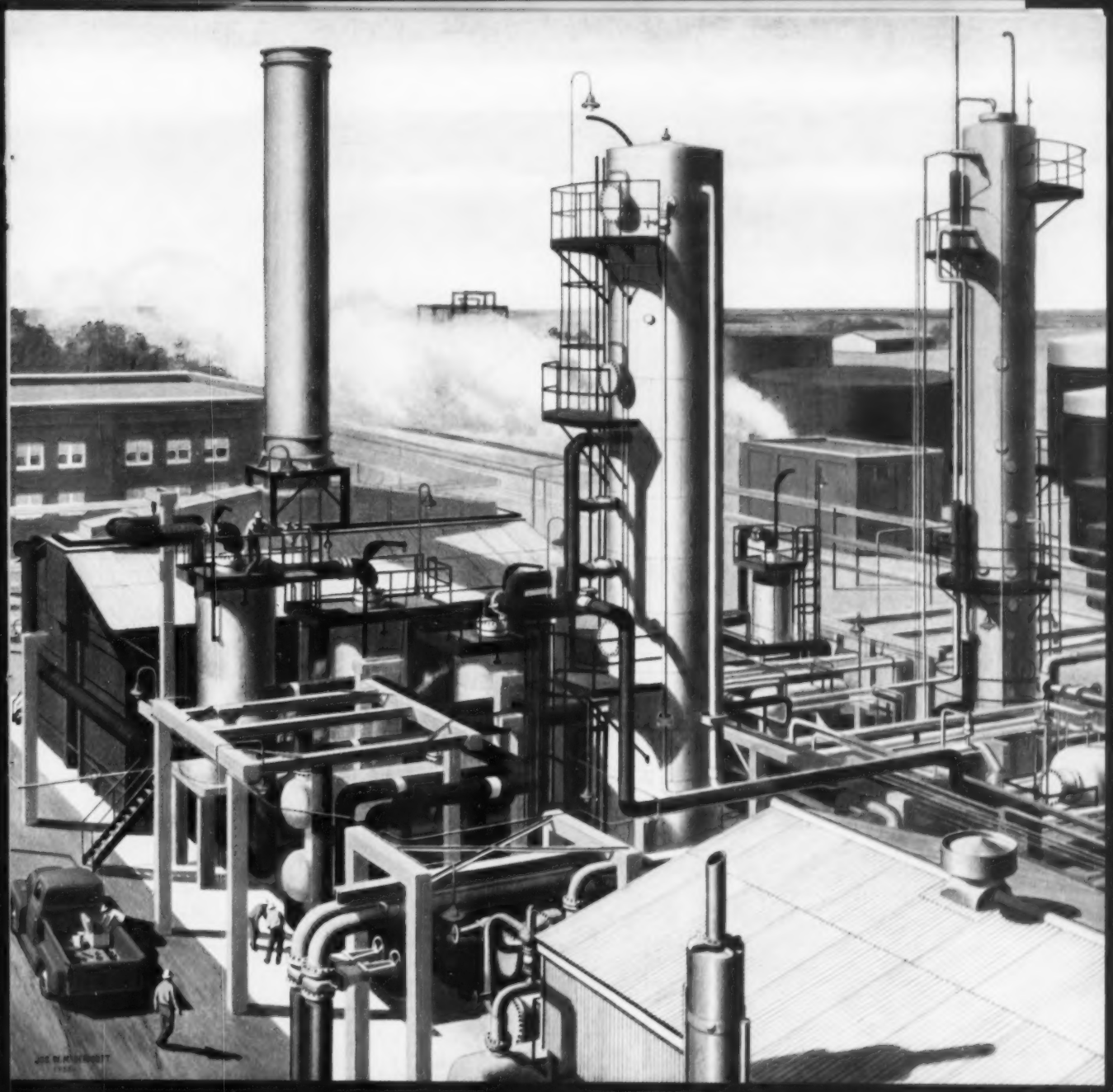


CROWN CENTRAL REFINERY

Crown Central Petroleum Corporation's new Houdriformer at its Pasadena Refinery near Houston, Texas is designed primarily for upgrading naphthas to produce high octane motor gasoline. Further processing makes possible the commercial production of aromatics and aviation blending stocks.

A feature of the Crown Central catalytic reforming unit is a "guard case" to desulphurize and pre-treat charge stocks. This small reactor is an integral part of the Houdriformer unit and strips the stock of contaminants, thereby eliminating the need for complicated pre-treating processes.

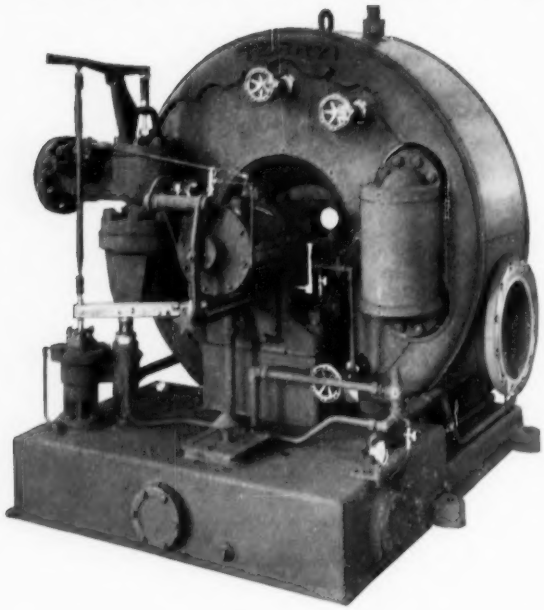
A new brochure on the Houdriforming Process is available on request. Write to: Houdry Process Corporation, 1528 Walnut Street, Philadelphia 2, Pa.

HOUDRY

PROCESS CORPORATION

Pioneer in Catalytic Processes

TROUBLE-FREE TURBINE OPERATION STARTS HERE



Terry solid wheel turbines have become a symbol for dependable, trouble-free operation. The reason—simplicity and ruggedness of construction.

Take the rotor, for instance. It's a solid forging in which a series of semi-circular buckets is milled. There are no separate parts to loosen or work out. Since the only function of the blades is to form a series of pockets, any wear which might occur would not materially affect horsepower or efficiency.

It is impossible for the blades to foul. They have large clearances and are further protected by the projecting rims at the sides of the wheel. As the side clearances are also very large, end play can do no harm.

Simplicity outside too—as you can see from the photograph of the 1500 HP at 3500 RPM solid wheel turbine above. This turbine is equipped with an oil relay governor and forced feed lubrication to the bearings.

For more about these *work horses of industry*, send for a copy of bulletin S-116. No cost or obligation.

THE TERRY STEAM TURBINE CO.
TERRY SQUARE, HARTFORD 1, CONN.

TERRY

TT-1209

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What's Happening . . .

ager will be kept informed of requisitions and the assumptions and computations upon which they were based. He may comment on the validity of any requisitions he questions.

The new organization will be staffed by civilian and military personnel, and personnel from the present Armed Services Petroleum Agency probably will be used. From the Army and Air Force, two general officers will be assigned to the agency as assistants.

An administrative committee, meeting monthly, will be set up to assist the executive director. It will consist of the assistants from the Army and Air Force, the assistant secretary of Defense (Comptroller) and the assistant secretary of Defense for supply and logistics.

The executive director will be responsible for direction and control of cataloging, standardization, net requirements, procurement, production, inspection, storage, distribution, disposal, transportation, maintenance and mobilization planning for petroleum.

Departments maintaining duplicating functions and activities will be required to eliminate them.

Higher Wage Rates Set for Industry

A number of petroleum companies have made 6-percent basic-wage increases—an offer generally accepted by the unions and one which apparently will set a new wage structure for the industry. In most cases, a shift differential also has been provided.

The increases usually have provided a minimum boost of 15 cents an hour for hourly-rated workers and $26 a month for salaried employes. Not all of the companies, however, offered minimum increases.

The lowest differential offered was 6 cents and 12 cents. Some unions sought 6 cents and 16 cents. The highest differential granted was 8 cents and 16 cents.

New Records Set In Synthetic-Rubber

New records for world production and consumption of synthetic-rubber were set in 1955. This is the report of the International Rubber Study Group. It does not include Communist countries.

World output of synthetic-rubber was estimated at 1,085,000 tons, compared with 716,388 tons in 1954 and the previous high of 935,622 tons in 1953.

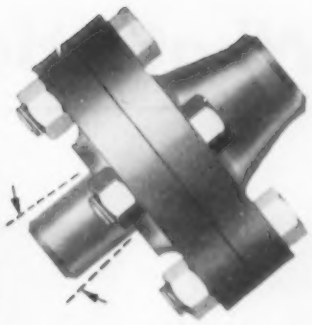
Consumption of synthetic rubber reached a new high of 1,055,000 tons, against 740,000 in 1954. The former record year for consumption was 1946 when the world used 912,000 tons of synthetic rubber.

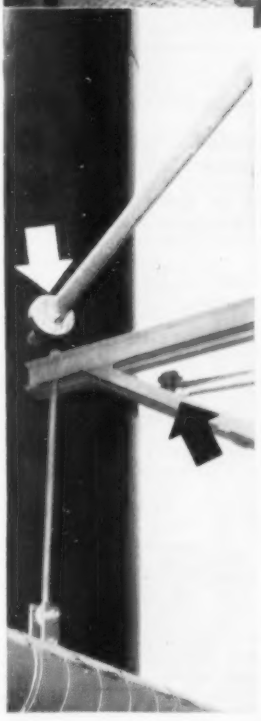
Plans Engineering Center

The Lummus Company will establish an Engineering Development Center in Newark, N. J. To house the new center, the company has purchased a 150,000-square-foot building in Newark.

Lummus, which has operated similar facilities in Bayonne, N. J., for the past 25 years, will use the new building for pilot-plant operation and process-development work.

HERE'S HOW
Refinery Engineers and Builders Use
BARCO FLEXIBLE STRUT JOINTS





— for Structural Applications

Barco Flexible Strut Joints are an important aid in *modern* refinery construction. A typical use is at the ends of struts for supporting or bracing large catalyst carrier lines or vent stacks on fluid catalytic crackers. In such cases, where horizontal lines require supports, two braces (with Barco Strut Joints in each) make costly "A" frames unnecessary. Other uses include guying tall vessels and columns and directing thermal movements of high temperature piping.

SIMPLE, VERSATILE!—The Barco Strut Joint is a dependable, compact, versatile fitting requiring practically no maintenance. It is a simple ball and socket that provides a point of flexibility. The close fit between ball and casing, allows for reversible loads, not possible with pin and clevis type braces. Barco Strut Joints support without restricting freedom of movement.

COMPLETE LINE—Available in following sizes and capacities: 1½"—8,000 lbs., 2"—12,000 lbs., 3"—20,000 lbs., 4"—50,000 lbs., 6"—130,000 lbs. Welding ends for field or shop use. Unique "Bar-Moly" treatment of wearing parts provides permanent dry lubrication for long service.

ENGINEERING SERVICE—Barco will be glad to work with your engineers in the selection of joints to meet your requirements. *Specifications and information on request.*

SEND for your copy of interesting new illustrated bulletin No. 28 showing OIL REFINERY AND PETROLEUM INDUSTRY applications for Barco Ball, Swing, and Strut Joints.

BARCO *Manufacturing Co.*

542D Hough Street • Barrington, Illinois

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What's Happening . . .

. . . *Among Men* in the Industry

Whyte

Haxby

C. D. Haxby, Rust Engineering Company, has been elected president of the National Constructors Association. Elected as vice president was **C. B. Whyte,** Procon, Inc. Both will serve on the executive committee. Others elected to the executive committee were:

D. W. Darnell, The Fluor Corporation, Ltd.; **O. F. Sieder,** H. K. Ferguson Company; **P. S. Klick, Jr.,** Foster Wheeler Corporation; **H. A. Denny,** Koppers Company, Inc., and **G. I. Seyhold,** Chemical Construction Company.

Paul L. Wetcher, C F Braun & Company, was elected Labor committee chairman, with the following as co-chairmen; **R. E. Atkinson,** Koppers Company, and **N. K. Steenhill,** Rust Engineering.

On the Safety committee, **C. A. Clore,** The Girdler Company, is chairman, with **H. B. Wallace,** Koppers, as co-chairman. **R. E. Atkinson,** Koppers, is chairman of the Foreign committee, and **F. L. Doherty,** Stone & Webster Engineering Company, is co-chairman. **J. J. O'Donnell,** The Lummus Company, is chairman of the Public Affairs committee.

Clark R. Miller has been named medical director of Tidewater Associated Oil Company in San Francisco. **John R. Rock** will serve as assistant to the employe-relations manager and supervise the company's employe-training activities. Both posts are newly-created.

Dr. Miller formerly was medical supervisor for the company's Western division. Until recently, Rock was assistant Western division employe relations supervisor.

William M. Holaday, on leave from Socony Mobil Oil Company, has taken office as the new Deputy Assistant Secretary of Defense for Research and Development. He recently had been named coordinator of new product planning for Socony Mobil, following service as director of research.

R. L. Minckler has been elected president of Wilmington Gasoline Company, recently-acquired subsidiary of General Petroleum Corporation. (See **What's Happening.**) **P. S. Magruder** and **R. O. Swayze** were named vice presidents, and **Paul E. Bermingham** will serve as vice president and solicitor. **A. D. Bennison** is treasurer; **M. W. Kibre,** secretary, and **E. H. Berge, director.** All are executives of General Petroleum; Magruder is executive vice president of General, and Swayze is vice president.

W. B. Cleveland has been named manager of Creole Petroleum Corporation's Venezuelan refinery at Amuay. Formerly manager of the Sales department, he replaces Calvin E. Cooper who retired.

An exchange of positions was made between **M. G. Ball** and **F. K. Davis.** Ball, who was superintendent of the Caripito district, was appointed assistant manager of the Amuay refinery. And Davis, who held that post, was sent to Caripito.

Kenneth G. Mackenzie has been honored by the American Standards Association, in recognition of his achievements in the development of standards. He heads Kenneth G. Mackenzie Associates, of Westport, Conn., and Chicago.

Mackenzie is a member of the Standards Council, responsible for the association's technical program. He represents the American Society for Testing Materials, of which he is a past president.

He received a citation which read: "The American Standards Association presents this certificate in recognition of contributions to the establishment of voluntary standards and in appreciation of the sound advise and devotion of energy to the furtherance of the standards movement as a means of advancing the national economy."

Louis W. Lerda has been named manager of the Employe Communcations division of Esso Standard Oil Company, succeeding **Harry D. Kolb.** Kolb has been assigned to develop new research projects in the employe-relations field.

H. A. W. Kidd has been appointed assistant to the manager of Magnolia Petroleum Company's Natural Gas department. For the past three years he has been assistant to the manager of the Socony Mobil Oil Company laboratories headquartered in New York.

Kidd

In his new position, Kidd will serve as consultant and advisor to both the Natural Gas and Distribution departments, and devote most of his time to the uses of lighter hydrocarbons in the refining and petrochemical industries.

Before joining Socony Mobil's research staff in New York, he was assistant to the director of Magnolia's research laboratories in Dallas. He was with the company there nine years. Prior to that he spent 15 years in research, technical service and production positions in the chemical industry.

Henry J. Ogorzaly has been named by Esso Research and Engineering Company to follow the company's nuclear activities affecting chemical and petroleum processes and products quality. Formerly assistant director of the Petroleum Development division, he will be succeeded by **Edward J. Gornowski.**

Barton

Closs

Paul D. Barton, since 1947 chief engineer of the Manufacturing department of Sun Oil Company, has been appointed director of engineering. Named as associate director was **George M. Closs,** manager of the company's Toledo, Ohio, refinery.

John F. Harron will succeed Closs as manager at Toledo. Formerly superintendent of refining Harron, in turn, will be replaced by **Herbert C. Thober,** who was operating assistant in the Distillates and Cracking division of the Ohio installation.

Barton, who joined the company in 1934, was assistant chief engineer in the Engineering department before he was made chief engineer of the Manufacturing department. He has been issued more than 15 patents, including those held with others on the original hot-contact-filtration process for making lube oil.

Closs, who joined the company in 1923, started at the Marcus Hook, Pa., refinery as a plant engineer. Four years later he was transferred to the Toledo refinery for construction duties, and in 1929 he was made plant engineer. He became assistant manager at Toledo in 1941 and manager in 1944.

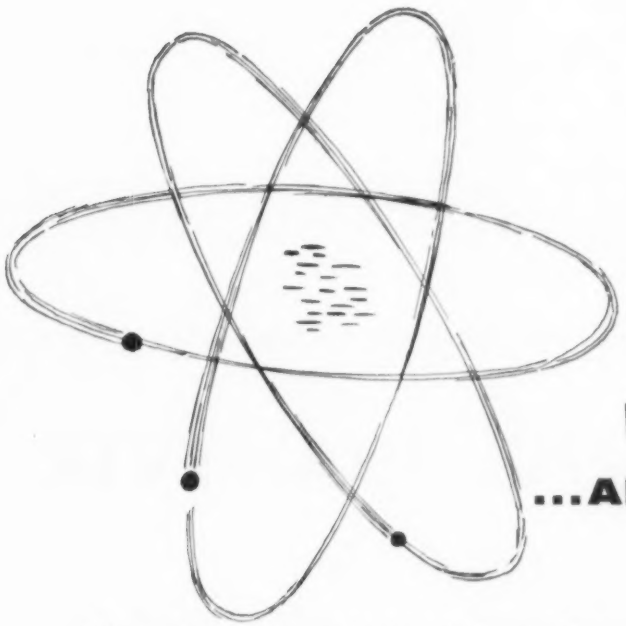
A. K. Doolittle has been appointed senior scientist in the Research department of Carbide and Carbon Chemicals Company, a division of Union Carbide and Carbon Corporation. He will direct a program of basic research in liquid-state physics. Doolittle, who joined Carbide and Carbon in 1932 as technical head of coatings research, has been assistant director of research since 1944.

J. H. Karchmer has been promoted to research specialist in Humble Oil & Refining Company's Research and Development division at Baytown, Texas. He will specialize in electrochemical and chromatographic analyses, and in nitrogen and sulphur chemistry.

Jacques L. Zakin, senior research technologist with Socony Mobil Oil Company's Technical Service department in Brooklyn, has been named winner of Socony Mobil's 1956 Incentive Fellowship Award.

The company established annual fellowships in 1947 to enable laboratory employes of outstanding ability, proficiency and inventiveness to further their academic training. Zakin is the fifteenth to receive the award.

The award winner's full salary continues for a period up to three years while he



Simplify Handling of Fluids, Vapors and Gases

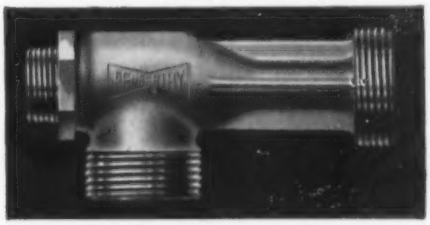
...AND "HOT" MATERIALS

Selected for use in certain Atomic Energy Commission operations, the simple sound design of Penberthy ejectors plus Penberthy "know-how" has provided dependable service in processes involving the handling of dangerous corrosive liquids and gases. These same advantages are being realized in chemical processing, dairy, food, textile, plating, paper and many other industries.

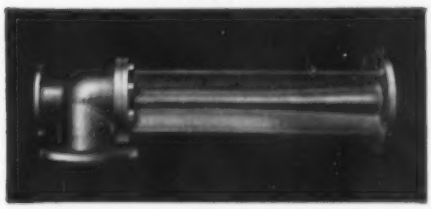
Trouble-free Penberthy ejectors (with no moving parts to get out of order) are available in bronze, iron, stainless steel, plastic and other materials . . . in standard and made-to-order designs. Get the facts. Write for Catalog 512R.

PENBERTHY INJECTOR COMPANY
Division of the Buffalo-Eclipse Corporation
1242 Holden Avenue **Detroit 2, Michigan**

Series 1A and 20A Ejectors perform efficiently over a wide range of operating conditions.



Series 60A fluid operated jet pump for lifting, elevating and blending liquids or slurries.



Special jet pump for handling corrosive chemicals. Stainless steel with flanged connections.

Special stainless steel where corrosion resistance and/or non-contamination are required.

Series 50 P corrosion-resisting Uscolite plastic hydraulic ejector. Rigid. Tough. Lightweight.

PENBERTHY EJECTORS

STEAM, AIR & LIQUID OPERATED FOR:

Liquid Transfer, Heating, Circulating, Aerating, Agitating, Mixing, Pumping, Blending and Exhausting Air or Vapor against High Vacuum.

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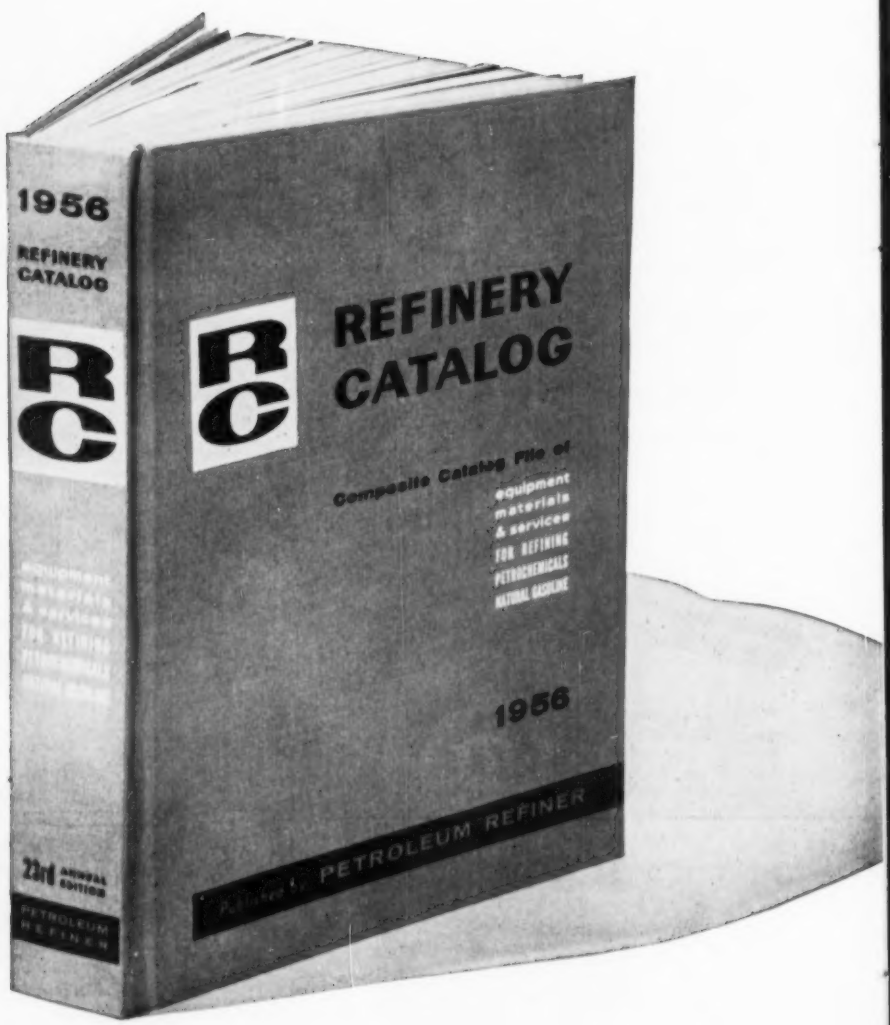

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MOST COMPLETE SINGLE SOURCE

..... of Equipment-Service Data in

– Refining
– Natural Gasoline
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Completely indexed and cross indexed . . . Saves Time
Refer to it when ordering . . . specifying . . . inquiring

Make your buying job easier, eliminate errors, reach for your copy of The Refinery Catalog and watch for quick, efficient results.

More Complete and Useful Than Ever

The Refinery Catalog is an indispensable tool, more valuable and useful this year than ever before. Here's part of what you'll find in it!

★ Complete or condensed catalogs of more than 270 manufacturers, service companies, and suppliers serving the industry.

★ Authoritative, up-to-date specifications and data.

★ Local sources of supply.

★ Convenient alphabetical index of manufacturers and a classified index of equipment, materials and services.

If you are not among the thousands of men in buying power jobs whose names have been submitted to us by their companies to receive a personal copy of the current Refinery Catalog, tell your immediate supervisor that you'd like to be included. In the meantime, you're sure to find a copy you can use somewhere nearby in your department. Remember to look for the large "RC" on the cover.

The REFINERY CATALOG

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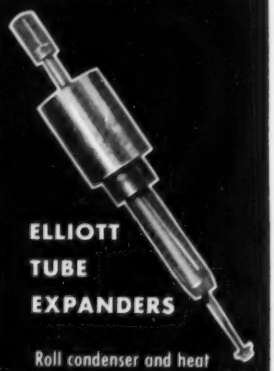
ELLIOTT EQUIPMENT ASSURES ACCURATE Tube Rolling!

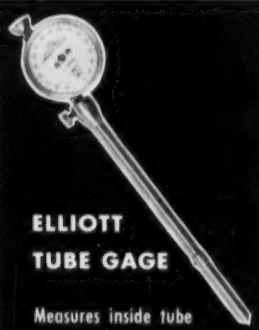


ELLIOTT TUBE EXPANDERS

Roll condenser and heat exchanger tubes quickly and accurately. Rotating, parallel self-feeding rolls insure good joints. For tubes ½ in through 1½ in.

Table for data on torque control setting
Time delay adjustment
Torque Control setting
Red light indicates power on
White light indicates tube is rolled
Motor cord
Power cord
Operating instructions
Voltage Balance indicator dial
Voltage Balance switch
Power switch
Motor selector switch
Remote signal light with 25-ft cord indicates when tube is rolled

The control box is equipped with heavy non-skid rubber feet. These also protect it against water on the floor, etc



ELLIOTT TUBE GAGE

Measures inside tube diameters on dial in thousandths of an inch. A quick guide for setting tube expanders for condenser and heat exchanger tubes. Three-point contact of hardened steel balls insures accurate measurements.

ELLIOTT ELECTRIC CONTROL

Assures tight, uniform tube joints everytime. It's a torque-limiting device that automatically balances outside voltage variables without the need of a separate voltage regulator.

Write for Descriptive Bulletin Y-40. Elliott Company, Lagonda Division, Springfield, Ohio.

ELLIOTT Company

Y6-2A

STEAM TURBINES • MOTORS • GENERATORS • DEAERATING HEATERS • EJECTORS • CONDENSERS • CENTRIFUGAL COMPRESSORS • TURBOCHARGERS • TUBE CLEANERS • STRAINERS

Men in the Industry . . .

carries on advanced studies. An unrestricted grant of $750 a year is given to the university selected by the winner to aid in defraying the cost of his education.

Zakin plans to work toward a doctorate in chemical engineering at New York University. With the Socony-Mobil since 1951, he is a graduate of Cornell University and holds a master's degree from Columbia University.

G. L. Brennan, a vice president of Warren Petroleum Corporation, has been elected a director, succeeding **Howard E. Felt** who resigned. Brennan, who joined the company as manager of the LP-Gas division in 1941, became vice president of the LP-Gas division early in 1954, when Felt, vice president of the division and a director, announced he planned to retire. Since his retirement, Felt has continued as a member of the board until his recent resignation.

Brennan

Edward J. Nopper has been appointed chief electrical engineer for Sun Oil Company's Manufacturing department. His duties will include general supervision of the important electrical distribution systems at Sun's three refineries.

J. Prince Warner has been named general manager of manufacturing for Esso Standard Oil Company. He succeeds **Harold G. Mangelsdorf,** who has been appointed to the company's executive committee.

For the past year, Warner has been general superintendent of Esso's Baltimore refinery. During this period, the plant completed a $20-million construction program.

He was general superintendent of the company's refinery at Baton Rouge, La., in 1952. The following year he was named assistant general manager of Esso's Louisiana division, and from that assignment he was moved to the post in Baltimore.

Mangelsdorf became an Esso director in 1954, and continued to serve as general manager of manufacturing. He had been named to this post less than a year before. He is a former general manager of Esso's East Coast Manufacturing division.

Both Warner and Mangelsdorf began their Esso careers at the Baton Rouge refinery.

George J. Peterschmidt has been elected president of The El Dorado Refining Company. He succeeds **T. A. Helling,** who was made chairman of the board. Named to succeed Peterschmidt as executive vice president and treasurer was **Sam L. Roberson.** Roberson had been vice president in charge of manufacturing.

Mason G. Lockwood, William M. Andrews and **Frank H. Newnam, Jr.,** all partners in Lockwood & Andrews, have changed the name of the Texas consulting firm to Lockwood, Andrews & Newnam. The concern has offices in Houston, Corpus Christi and Victoria.

A number of key staff member were made associates of the firm. They are E. A.

For more data on advertised products, use Readers' Service Cards, last page.

HOT-OIL PUMPS *Perform* IN CARBON BISULFIDE PLANT

PEERLESS PUMPS

Peerless Type PR PUMPS Perform WITH HIGHER EFFICIENCY, LOWER COSTS, IN MAJOR CHEMICAL PLANT...

EFFICIENT—A Peerless Type PR pump is an extremely rugged and dependable pump, designed especially to meet the complex requirements of liquid transfer in the process industries with complete efficiency. Its NPSH characteristics are excellent.

MODERN DESIGN—A Peerless Type PR pump is a modern pump, incorporating the most advanced design and construction features of center-line-mount-pumps yet providing every consideration for operational dependability and safety.

ECONOMY—A Peerless Type PR pump is not an expensive pump. Correctly applied it will meet every requirement for economical operation both in terms of "in service continuity" and its ease of maintenance when inspection or repair is indicated.

TYPES—A Peerless Type PR pump is available in packing gland or mechanical shaft seal (Type PRS) types. Top or end suction designs are available. Heavily constructed for high temperatures and pressures. Truly a modern pump designed especially for chemical process pumping. Find out about it today.

Type PR PUMP CHARACTERISTICS

CAPACITIES	up to 1000 gpm
OPERATING HEADS	up to 625 feet
CASE PRESSURES	up to 400 psig
DRIVES	horizontal electric motor is standard; other types as required
MATERIAL OF CONSTRUCTION	liquid end can be of any material suitable to intended service

PEERLESS PUMP DIVISION

FOOD MACHINERY AND CHEMICAL CORPORATION

Factories: Los Angeles, Calif. and Indianapolis, Indiana.

Offices: New York; Atlanta; Chicago; St. Louis; Indianapolis; Phoenix; Fresno; Los Angeles; Plainview and Lubbock, Texas; Albuquerque, New Mexico.

Distributors in Principal Cities; Consult your Telephone Directory.

PEERLESS PUMPS fmc

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Please send us copy of Bulletin No. B-1605 describing Peerless Type PR and Type PRS Pumps.

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COLD DRAWN SEAMLESS STEEL

TUBING

UP TO

58 FEET LONG

FOR

CONDENSERS

and **HEAT**

EXCHANGERS

Now you can get STRAIGHT lengths up to 58 feet long...at Pacific Tube

Pacific Tube Company has added new pickling facilities, new hydrostatic testing equipment...with the longest draw bench in the west to quantity-produce for you, straight lengths of Seamless Tubing up to 58 feet long. Pacific Seamless Steel Tubing is "Quality Controlled" to insure workability, accurate bending, flarability and long life. It is precision drawn to meet critical specifications and tolerances.

Pacific Tube Company is strategically located to serve you efficiently, economically & promptly.

If you have a tubing problem, ask the Pacific experts for help...you'll be glad you did.

Pacific TUBE COMPANY

Manufacturers of

STEEL TUBING AND BARS

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LOS ANGELES 22, CALIF.
Telephone: RAymond 3-1331

Our movie... "Steel Tubes for Industry" available without charge.

Men in the Industry...

Brinkman, in charge of the Victoria office; **C. W. Henderson,** head of the Civil Engineering division; **Homer C. Innis,** in charge at Corpus Christi, and **S. E. Kehoe,** who is head of the Office Engineering division.

Also named as associates were **A. J. Malloy,** who heads the Structural Engineering division; **H. L. Murchison,** in charge of the Architectural division, and **Hal K. Puckett,** head of the Mechanical Engineering division.

Luther R. Hill, former president of Process Designs, Inc., has joined Arthur G. McKee & Company as process coordinator of its Petroleum division. Hill was with The M. W. Kellogg Company from 1929 to 1952, when he resigned as head of the Processing department to form Process Design, a Ridgewood, N. J., firm. With Kellogg, he served as process and project engineer and was advanced to process manager and project manager before he was given charge of the processing department.

Hill

Lyle Lovell has been promoted to group leader in the Technical Service division at the American Oil Company's Texas City, Texas, refinery. Lovell has been with Amco since 1951. He is a chemical-engineering graduate from the University of Oklahoma.

S. O. Brady has been promoted to senior research chemical engineer in the Research and Development division at Humble Oil & Refining Company's Baytown, Texas, refinery. He will engage in developing processes for abating air and stream pollution, and corrosion and deterioration of refinery equipment.

A. H. Hayes, now general superintendent of the Standard Oil Company (Indiana) refinery at Whiting, Ind., has been named senior assistant superintendent. The new title of assistant manager will be used at all of the company's refineries, applying to positions now general superintendent or assistant general superintendent.

F. H. Blunck, general superintendent at the Wood River, Ill., refinery, has been promoted to a new position of manager of the Unit Operations division. He will be transferred to the Manufacturing department's general office in Chicago. Named to replace Dr. Blunck as assistant manager at Wood River was **L. H. Butterworth,** formerly general superintendent at the Casper, Wyo., refinery.

Archie D. Gray has been elected general counsel for Gulf Oil Corporation. He replaces **David Proctor** who resigned the post but will continue as a director and executive vice president. Gray has been with the company since 1935 and in the general office at Pittsburgh since 1953.

George T. Goggin, executive vice president of Douglas Oil Company of California, has been elected president of the Independent Refiners Association of California. Elected as vice president was **Ralph W. Forch,** vice president of Wilshire Oil Company.

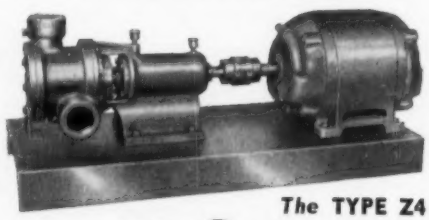
Malcolm McDuffie, who is vice presi-

Is the Handling of

LIQUEFIED PETROLEUM GASES, REFRIGERANTS and other LIGHT NON-VISCOUS LIQUIDS

Bothersome to You?

IT NEED NOT BE



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APCO *Process* PUMPS

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AURORA Always PUMPS

You are urged to get acquainted with this complete answer to many of the most difficult pumping tasks of modern industry. The characteristics of the most advanced turbine-type pump, the APCO, combine with special new design features, special metals where required to insure SURE RESULTS. May we tell you more?

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multi-plant production

skilled technical service

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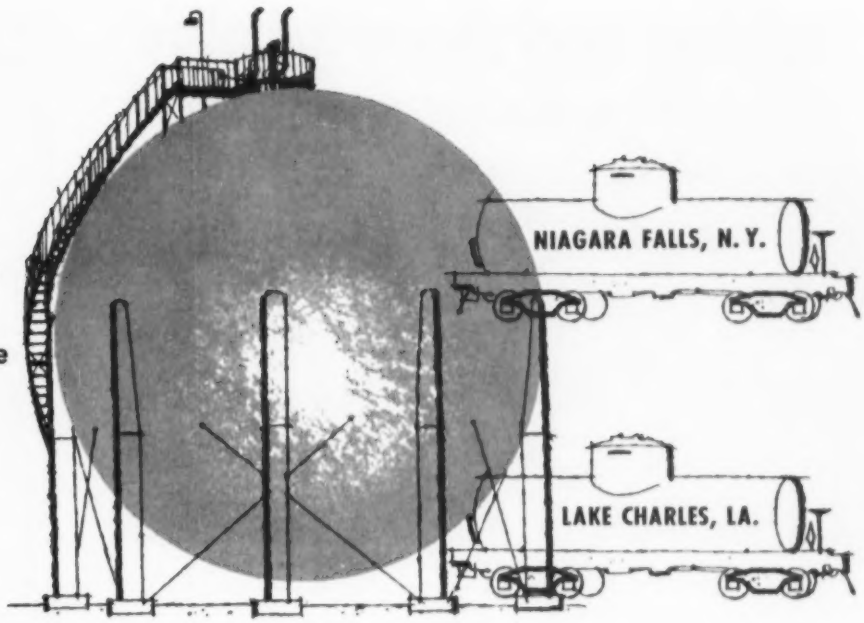

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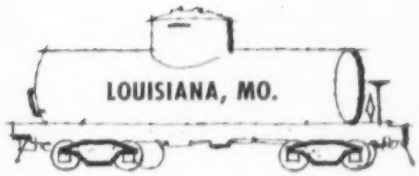
Require dependable deliveries of ammonia . . . coordinated with your production schedule? It will pay you to order from Mathieson. Here's why:

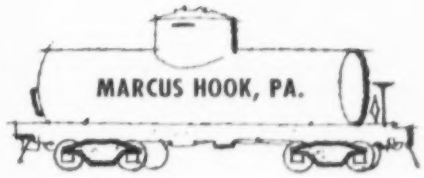
Five shipping points assure maximum protection against supply interruptions.

Expert technical service . . . particularly in the pulp and paper and metals processing fields . . . is always available.

Balanced output to industry and agriculture eliminates seasonal shortages.

Talk over your ammonia requirements with an Olin Mathieson representative soon. Let him show you why more people buy more chemicals to better advantage from Olin Mathieson . . . America's prime producer of basic industrial chemicals.





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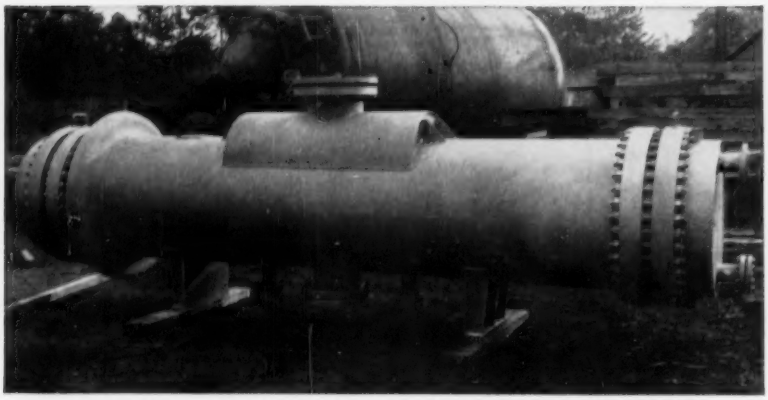
ORGANIC CHEMICALS: Ethylene Oxide • Ethylene Glycols • Polyethylene Glycols • Glycol Ether Solvents • Ethylene Dichloride • Dichloroethylether Formaldehyde • Methanol • Sodium Methylate • Hexamine • Ethylene Diamine • Polyamines • Ethanolamines • Trichlorophenol • Trichlorobenzene

Stainless steel plus nickel alloy equals corrosion-resistance

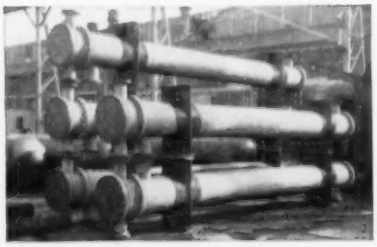


Inconel and stainless heat exchanger built for Barrett Division, Allied Chemical & Dye Corporation. Shell Diameter: 30". Tube Length: 12' 0". Tubes: 1" O.D. x 14 ga. Tube Sheet Thickness: 2". Materials: Inconel shell, tubes, tube sheets. Stainless steel heads, Type 316L.

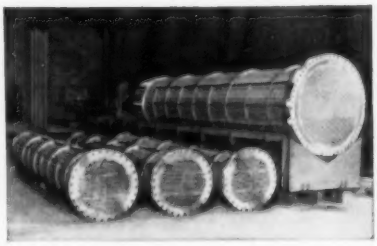
Corrosion-resistant materials a heat exchanger specialty at Downingtown

We have the engineering, welding and fabricating experience to turn out your corrosion-resistant exchangers in the materials you specify: stainless, nickel, nickel alloy, aluminum bronze, carbon and many others. Our design recommendations often save money. Send for Bulletin HE. Your engineers will find it useful.

Aluminum bronze for these five coolers saved the customer 25% on equipment costs, assured corrosion resistance. Each fixed tube sheet unit is 20" in diameter x 20' tube length. Each has 282 aluminum bronze tubes ¾" O.D. x 12 ga. Centrifugally cast channels. Design pressure: 150 pounds per square inch on both shell and tube sides.



Stainless steel Type 304 is the material for these four tube bundles. The large one fits a 37" shell, has 1225 stainless tubes, ¾" O.D. x 14' 0" long. Tube sheet: 2⅞" thick. Baffles: 3/16" thick. The other three bundles are 22" in diameter; each contains 352 tubes ¾" O.D. x 16 ga. x 12' 0" long. Tube sheets: 1¼" thick. Baffles: ¼" thick. All stainless steel.



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DOWNINGTOWN IRON WORKS INC. Hackney

CONTAINERS AND PRESSURE VESSELS FOR GASES, LIQUIDS AND SOLIDS

Men in the Industry . . .

dent of Mohawk Petroleum Corporation, will serve as secretary-treasurer. All three were elected as directors.

Others to serve on the board are **E. J. Barnes**, vice president of Macmillan Petroleum Corporation; **R. L. Feldman**, vice president of Golden Bear Oil Company; **D. S. Fletcher**, co-owner of Fletcher Oil Company, and **Morton Sterling**, executive vice president of Sunset Oil Company.

A. J. Broggini has been elected executive vice president and chairman of the executive committee of Badger Manufacturing Company. He has been a director of the company and served on its executive committee since 1955.

Broggini

Before joining Badger Manufacturing Company in 1952, Broggini was associated with the former E. B. Badger & Sons Company. He joined that concern in 1937 and served in various engineering and executive capacities.

George P. Bunn, honored with the Hanlon Award in 1954, is to fill a newly-created position as executive staff assistant on natural-gas liquids. And **G. W. McCullough,** a vice president since 1953, will become manager of the Natural Gasoline department.

J. M. Houchin will be chairman of the company's Operating committee—a position formerly held by McCullough. And **Harry Fair,** who continues as vice chairman of the Operating Committee, will be chairman of the Product and Process committee.

Bunn, who joined the Natural Gasoline department in 1922 as an engineer and later became its superintendent, has been manager of the department since 1930.

McCullough spent 23 years in the department, advancing to assistant to the manager. In 1948, he was made vice president and general manager of the new Phillips Chemical Company. He has been chairman of the Operating Committee since 1951 and a vice president of Phillips Petroleum since 1953.

Fair joined Phillips in 1939 and served continually in the Refining department until 1953, when he became vice chairman of the Operating committee. He is a former superintendent of the company's Kansas City, Kansas, refinery.

Elwood G. Glass, Jr., has been named coordinator of recruitment on a company-wide basis for The Standard Oil Company (Ohio). For the past 16 years, Glass has held various positions in the company's Manufacturing department. In his new assignment, he will assist all departments in obtaining technical and professional personnel.

George F. Klein, Jr., formerly chief engineer of Catalytic Construction Company, has been elected vice president in charge of engineering. He also will serve as a member of the board.

Prior to his September 1955 appointment as chief engineer, Klein was manager of Catalytic's Process Engineering department. In his new position, he will

These Speedomax recorders, teamed with Thermal Conductivity Analyzers on the synthesis unit (right), chart final yield (far left), and H_2-N_2 ratio before and after recycle gas enters feed stream.

L&N Analyzers Help The Atlantic Refining Co. Produce Maximum Ammonia Yield Economically

At The Atlantic Refining Company's modern ammonia plant in Philadelphia, peak performance depends on holding a precise hydrogen-nitrogen ratio to the converter, for maximum ammonia yield. A team of L&N Thermal Conductivity Analyzers with Speedomax® recorders handles the vital measuring jobs involved.

The H_2-N_2 ratio itself is so important that The Atlantic Refining Company operates two identical L&N Analyzers on the feed stream, one before and one after entry of recycle gas. These continuously record H_2 over a range of 65 to 85% while another Analyzer, calibrated 0 to 20% NH_3, records ammonia yield from the converter, and the amount returned in the recycled gas stream.

Feed hydrogen for the process is a by-product of The Atlantic Refining Company's design of catalytic reformer, known throughout the industry as a Catformer.

The Atlantic Refining Company's applications are typical of hundreds of successful jobs these recording and controlling L&N Analyzers are doing, not only in other ammonia synthesis plants, but on widely varied measurements throughout the process industries. For complete product data, write for Folder ND46-91(2). Or, to find how analytical control can benefit specific processes you have in mind, outline your problem for our engineers without obligation. Our address—Leeds & Northrup Co., 4923 Stenton Ave., Phila. 44, Pa.

LEEDS *instruments* **NORTHRUP** *automatic controls • furnaces*

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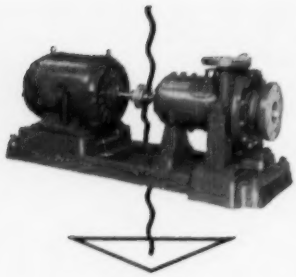

How to have a Big Family ... and be happy, too

We're talking about a "family" of pumps for a process plant.

It's Dean Brothers Series 10 standard centrifugal pumps. The eleven members of this family can do almost anything in the way of moving liquids. They can pump as little as 10 gallons a minute or as many as 700. Total dynamic head can be anything from 25 feet up to 400. The temperature of the liquid can be as low as 250° F. below zero or as high as 850° above. Working pressures range from a 30-inch vacuum to 400 lbs. per sq. in., gauge.

But the thing that makes these pumps one big happy family will make you happy, too. They're all built from the same parts with the exception of the Casing, Impeller and Suction Nozzle. And for pumping temperatures above 350° F., the cradle housing is integrally water-jacketed. Otherwise, these pumps are all alike. One shaft fits all pumps. Likewise one shaft sleeve and one set of packing or one mechanical seal. The bearings are the same and so are all other parts throughout the entire family.

When you get all this—plus mechanical reliability usually found only in costly, individually-engineered pumps—who wouldn't be happy with a family of Dean Brothers standard centrifugal process pumps? Why don't you get all the facts about these truly remarkable pumps?* Send for Circular No. 184A.

*Series 10, Series 20 and Series 30—to 7,000 gallons per minute capacity.

HOW PUMPS, "FAMILY STYLE," PAY OFF

Initial cost is lower than if each pump was an "individualist." Factory assembly from *parts in stock* assures prompt delivery.

Spare parts inventory is small—less investment . . . less storage space . . . less time to handle and keep track of.

Maintenance time is reduced. Once a man learns his way around one pump, it's the same for all the rest. In emergencies, this can mean less downtime.

DEAN BROTHERS PUMPS INC.

INDIANAPOLIS 7, INDIANA

Centrifugal and Reciprocating Pumps • Since 1869

Men in the Industry . . .

have charge of all engineering for projects handled by the company.

Before joining Catalytic, Klein was chief engineer for Spencer Chemical Company. He also served Refinery Engineering Company as chief engineer and held supervisory positions with Allied Chemical & Dye Corporation and Hercules Powder Company.

Jackson

Baker

R. R. Jackson, formerly director of manufacturing for Mobil Overseas Oil Company, Inc., has been appointed general manager of the Manufacturing department of Socony Mobil Oil Company, Inc. He also will serve as chairman of the company's Manufacturing committee.

Named to replace Jackson as head of manufacturing for the overseas company is **Charles P. Baker.** He has been manager of Socony Mobil's refining operations and vice chairman of the Manufacturing committee.

Until Jackson was named chairman of the committee, **George S. Dunham,** Socony Mobil director and executive in charge of manufacturing, had held the post.

Jackson started with the company as a chemist at the Beaumont, Texas, refinery of its affiliated Magnolia Petroleum Company. He was made superintendent of the refinery in 1936, and in 1947 he was appointed manager of Socony Mobil's refinery at Paulsboro, N. J. He became a member of the Manufacturing committee in 1950.

In 1953 he served as director of the Refining division, and before becoming manager of the company's foreign refining operations, he served the Petroleum Administration for Defense. He joined Mobil Overseas Company when it was formed in 1955.

Baker, who also started at Beaumont, was once associated with Houdry Process Corporation and later served at Socony Mobil's Research and Development Laboratories in Paulsboro. In 1943, he served the Petroleum Administration for War.

Frank C. Ware has been appointed executive vice president of Aenta Oil Company, succeeding **Clive M. Alexander** who retired after 25 years with the company. Ware has been associated with Ashland Oil & Refining Company, of which Aenta is a division, since 1934. Dr. Alexander had been a director and vice president of Aenta since 1939. He was made executive vice president in 1951.

Herman L. Boyle, director of industrial relations for Standard Oil Company (Indiana), is being promoted to manager of a new Organization department. The Industrial Relations department will be re-named the Employe Relations department. It will be under the direction

For more data on advertised products, use Readers' Service Cards, last page.

Moisture-resistant. K&M Apac sheets are used on the ceiling of this toll entrance and custom office inspection enclosure at the Port Huron, Michigan, Blue Water International Bridge. The moisture in the air at the bridge won't harm them.

You'll be wise to choose

K&M APAC

Asbestos-Cement Sheets

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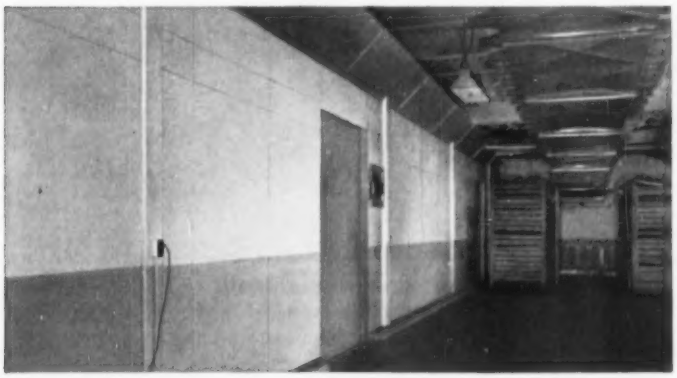
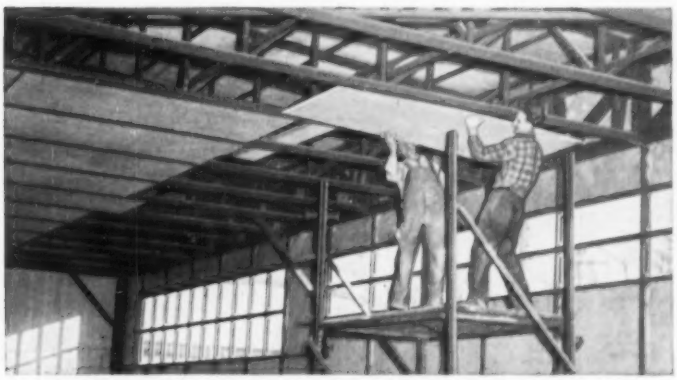
Interiors—Exteriors

Remarkable economy!



Temperature, humidity safeguards. Walls of K&M Apac sheets give dependable aid to a cigar manufacturer in an important process—where temperature and humidity are accurately controlled.



All-purpose sheets. This photo shows K&M Apac sheets being applied on a building where they are used for both outside and inside walls as well as for ceilings.

You'll find a thousand and one uses for these flat asbestos-cement sheets: as an interior and exterior siding, office paneling, plant and office ceilings, machine shop sheathing, stock room sidewalls, basement partitions, linings for elevator casings. Use them almost everywhere, inside and outside.

Built to last. K&M Apac sheets are made of two practically indestructible materials, asbestos fiber and portland cement. They won't burn, rot, or corrode. And they never need protective paint.

Look over the illustrations. See a few of the many places where Apac sheets are applied. Then contact your K&M distributor, and ask him to tell you more about low-cost K&M Apac sheets. Informative folders also available on request. Address inquiries to our headquarters in Ambler, Pa.

KEASBEY & MATTISON
COMPANY • AMBLER • PENNSYLVANIA

K&M best in asbestos

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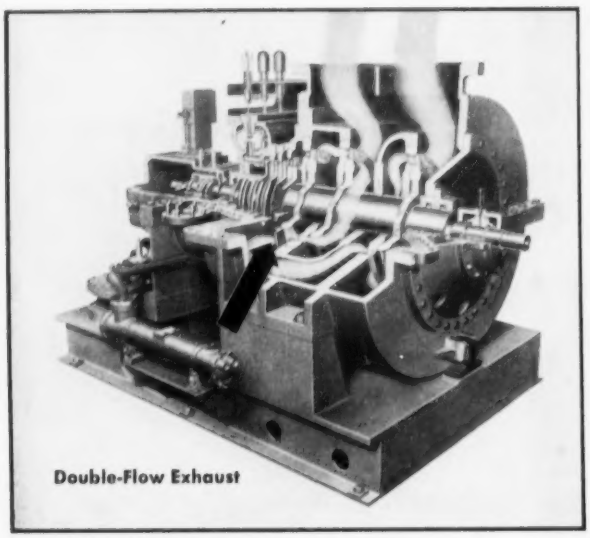
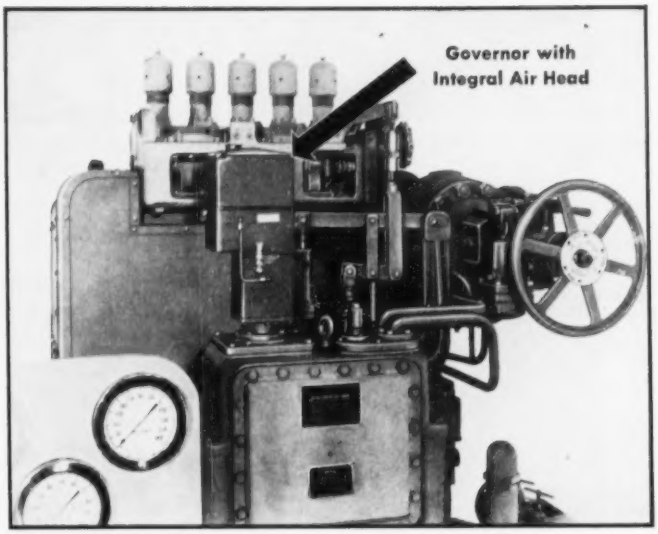
In high-speed turbines . . . why does in total horsepower and



GREATER RELIABILITY. Worthington's rugged construction pays off in extra reliability. Solid rotor for modern high speeds, double-flow exhaust where large volumes of steam are used in condensing operation, and Kingsbury type thrust bearings are just a few of the features that assure safety and dependable service on your vital compressor and blower drives.



ACCURATE SPEED REGULATION. Exclusive Worthington governing system using governor with integral air motor gives you speed control response to .04 psi change in control pressure. And it provides for remote automatic operation if you need it. The oil relay type governor so equipped instantaneously controls pressure or volume delivered by the compressor regardless of steam variations.

Where turbine-driven compressors and blowers are used, down-time is usually mighty expensive. Particularly so if failure can bring a continuous process to a standstill. In the case of high-speed/high-horsepower compressor-drive turbines, your surest way to design reliability into your plant is to specify the turbine line with best *proven* performance.

Compressor-drive turbine installations up to 12,000 rpm, and 24,000 hp, show Worthington leads in application engineering, design, reliability.

Worthington compressor-drive turbines are conservatively built with all stresses carefully calculated and kept well within established safety margins. Also, measured load tests are performed on every unit at the factory with modern facilities, under the watchful eyes of highly trained personnel.

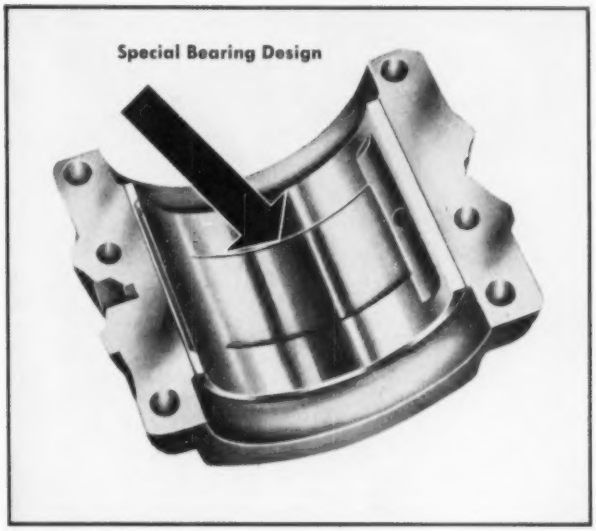
One feature seldom claimed is that of lowest price. That is inconsistent with quality, and quality is something Worthington engineers will not compromise. For critical operations, buying the best is lowest cost insurance against process equipment failure.

Get the complete story of high-speed/high-horsepower compressor-drive turbines by writing Worthington Corporation, A&SP-Turbines, Harrison, New Jersey. Ask for your personal copy of Bulletin 1966.

On Vital Compressor and Blower-Drive Applications . . . It Costs Less to Invest in the Best!

WORTHINGTON

WORTHINGTON lead all others number of installations?

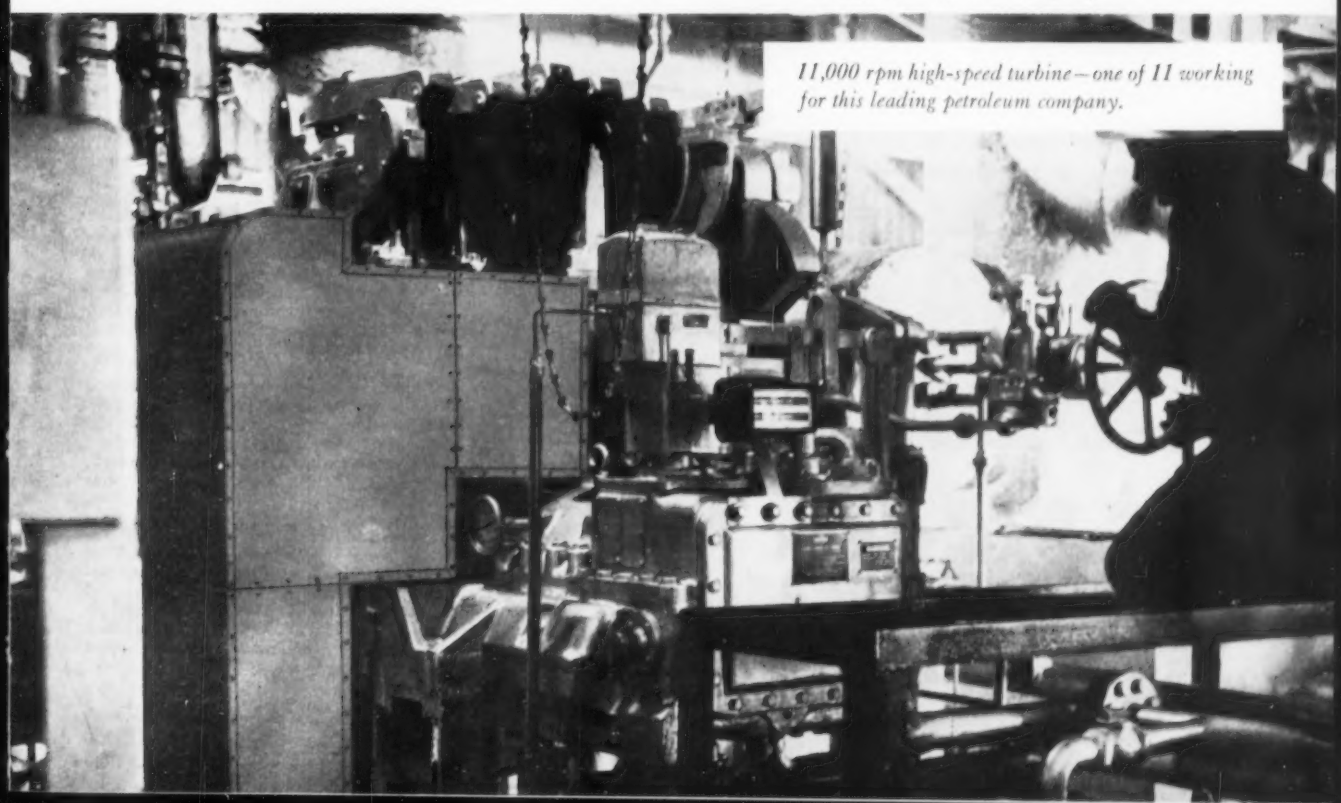


To meet turbine spec's. 4000 Hp- 7250 RPM -Steam 210 #-550° -26½"
WORTHINGTON GIVES YOU ALL THIS—CHECK AND COMPARE:

	Feature	WORTHINGTON	Company A	Company B	Company C
Rotor	Solid—to withstand extreme stresses.	✓			
Main Bearings	Anti oil-whip—for longer turbine life.	✓			
Thrust Bearing	Kingsbury type—for proven reliability.	✓			
Automatic Nozzle Control	Cam operated—for economy and better control.	✓			
Governor	Has integral air motor—for more accurate control.	✓			
Type Construction	Double flow exhaust for economy and long life.	✓			
Packing	Labyrinth—for most effective seal at high speed.	✓			
Test	Load test—to be sure you get what you ordered.	✓			

LOWER MAINTENANCE COST. One important example of construction used to help eliminate non-scheduled maintenance is Worthington's anti oil-whip bearing. During operation a pocket (arrow) in the upper half of the bearing builds up a pressure pad of oil. High pressure here creates a downward force on the journal, holding it in place in the bearing, preventing destructive vibration.

LONGER LIFE. A long, trouble-free life can be attributed to no *one* turbine feature, but rather a combination of many engineering advances. Compare design features yourself, one by one. Far ahead of any other manufacturer in the compressor-drive field, Worthington's first compressor-drive turbine built in 1927 is still working around the clock, in a large Eastern gas plant.



11,000 rpm high-speed turbine—one of 11 working for this leading petroleum company.

YOU GET 3 BIG SAVINGS

WITH STANDARD R-S BUTTERFLY VALVES

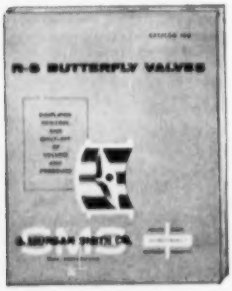
IN CATALOG 160

Based on 20 years' experience in process industry applications, R-S Butterfly Valves are now standardized. All components for those most commonly used, in sizes from 4" to 48", are carried in stock. By specifying standard R-S Valves, you now:

1. SAVE ON INITIAL DELIVERY – You can be sure of immediate service, because standard R-S Valves are ready for faster assembly and shipment.

2. SPEED REPLACEMENTS – Availability and faster delivery on standard R-S Valves can help you solve replacement problems and avoid costly, unscheduled shutdowns.

3. ELIMINATE ENGINEERING – In this new Catalog 160, you get the complete dimensions, layout drawings, specifications and materials for all pressure ratings of R-S Butterfly Valves that are now standardized. Data on operators and positioners is included. As new ratings are standardized, other sections will be published. To get a free copy and assure yourself of future sections, contact your SMS representative or write S. Morgan Smith Company, York, Penna.



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HYDRAULIC TURBINES · GATES & HOISTS · TRASH RAKES · PUMPS · ACCESSORIES

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AFFILIATE: S. MORGAN SMITH, CANADA, LIMITED • TORONTO

Men in the Industry . . .

of **J. Howell Turner,** presently director of employe relations with California & Hawaiian Sugar Refining Corporation in San Francisco.

Howard F. Thompson has been promoted to resident engineer at the Sinclair Refining Company refinery in Marcus Hook, Pa. He succeeds **John C. Weber,** who is retiring after 32 years with the company.

Thompson

Thompson started at the Marcus Hook refinery while a cooperative engineering student at Drexel Institute of Technology. He became a full-time technical employe in 1933 and in 1942, was made chief inspector. Three years later he was promoted to chief technician and became operating superintendent in 1952.

Weber joined Sinclair Refining as a draftsman in 1924, during the period the Marcus Hook refinery was being built. He was placed in charge of engineering at the plant in 1925.

Robert E. Maescher has been appointed assistant to the superintendent of the Torrance, Calif., refinery of General Petroleum Corporation. Except for two years at the company's Vernon, Calif., laboratories, Maescher has been assigned to the refinery since he joined the company in 1938.

George S. Lambert has been named director of the Plant Personnel division of The Atlantic Refining Company. He will be responsible for personnel activities at the company's refineries at Philadelphia and Atreco, Texas, the Research and Development department at Philadelphia and several other groups.

Carl G. Riege will succeed Lambert as director of the Office and Foreign Personnel division. He will direct personnel activities for headquarters personnel in Philadelphia and employes in Venezuela and Brazil. Riege joined Atlantic in 1937; Lambert has been with the company since 1938.

Rush F. McCleary has been appointed general manager of the Research and Development department of Jefferson Chemical Company Inc. With The Texas Company for the past 16 years, Dr. McCleary had been supervisor of chemical research for that company since mid-1954. He will be in the Jefferson offices at Houston.

Donald Q. Kern has organized a new Cleveland firm specializing in thermal-process technology, with emphasis on the design, engineering and marketing of thermal-process components. The concern, known as D. Q. Kern Associates, has branches in New York and Washington, D. C.

Connected with the organization are five associates prominent in the fields of distillation, high-pressure techniques, nuclear engineering, heat transfer and thermodynamics. The supporting staff is made up of 50 chemical, mechanical and structural engineers, detailers, analysts and draftsmen.

The **FOX Gas Processing Plant** was designed and constructed by Hudson in collaboration with Signal Oil and Gas Company. The plant design includes features reflecting a combination of the long experience of Signal in the operation of similar plants with the experience of Hudson in designing, constructing and initially operating more than 100 major projects for the oil and gas industry.

When additions now in progress are completed by Hudson, approximately 60 million cubic feet per day of casinghead gas from the Fox and nearby fields of Carter County, Oklahoma, will be processed, and about 3,000 barrels per day of finished products will be recovered from the gas.

Hudson is happy to add Signal Oil and Gas Company to its long list of clients, and particularly proud that through the coordinated efforts of Signal and Hudson this major project was completed in 7 months — from first discussion to smoothly operating plant.

DESIGNERS AND CONSTRUCTORS OF
OIL AND GAS PROCESSING PLANTS

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ENGINEERING CORPORATION

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A symphony orchestra, choral group, dramatic cast, guest soloists—all blend music enjoyment with education on the Standard School Broadcast. It's heard in 54,000 classrooms throughout the West, Alaska and Hawaii—and it's programmed for your entertainment at home, too. Why not tune in this Thursday...see your newspaper radio log for time and station.

NOW IN ITS TWENTY-EIGHTH YEAR

Presented by STANDARD OIL COMPANY OF CALIFORNIA

What Suppliers Are Doing . . .

Graham Maxey Gordon Turner Wilber Hudson Springer Kirby Clark

Edward K. Graham, Jr., is principal of a Houston concern which has been designated as exculsive sales agency for **Conoflow Corporation** in the Houston-Gulf Coast area. The concern, E. K. Graham Company, was formed in January, 1955, as a manufacturers representative for the process-control field in that area.

Frank P. Maxey has joined **Frontier Chemical Company** as a sales representative. He will operate out of Dallas. Maxey was associated for several years with Sharples Chemical Division in Philadelphia.

David D. Gordon has been appointed sales manager for Fulton Sylphon division of **Robertshaw-Fulton Controls Company.** He will have charge of the Los Angeles office, replacing **W. J. Hajek,** who has been transferred to Chicago. Gordon has been with the organization 13 years.

George K. Turner becomes chief electronics engineer with Spinco division of **Beckman Instruments, Inc.** He previously was a senior engineer in the Military Electronics division of Hycon Manufacturing Company in Pasadena, Calif. He has been with Alabama Engineering and Tool Corporation, North American Aviation Corporation and Consolidated Engineering Corporation.

John J. Wilber has been appointed manager of **Bailey Meter Company's** Cleveland district sales office. He succeeds **C. C. McClelland** who retired. Wilber started with the company in 1941 as a sales-service engineer assigned to the Cleveland office.

Earl Hudson, assistant general manager of **Rockwell Manufacturing Company's** gas-meter plant at DuBoise, Pa., has been named general manager of the company's new meter and valve plant at Porterville, Calif. Hudson went to work at the DuBoise plant in 1937, later becoming paymaster and personnel manager, purchasing agent and assistant to the general manager for purchasing and production.

Charles W. Springer has been named to a new post as director of research and development for **Graver Tank & Manufacturing Company.** A vice president, he has been heading the company's eastern sales activities.

Tom P. Kirby heads a new Central Sales district set up by **Electric Steel Foundary Company.** The new district will handle sales east of the Rockies and areas of the South. Kirby was manager of the Gulf, Atlantic and Midwest branches, now included in the new district.

John Robert Clark, Jr., has joined the sales organization of the Chemicals division of **Houdry Process Corporation.** He previously was with Washington Brick Company, at Muirkirk, Md., first as plant

How Metallizing saves money in refineries

cuts machine repair costs 80%—
cuts equipment "down-time"—
permits reduced spare parts stocks

Practically any worn machine part—repaired for only 15 or 20% of replacement cost—in minutes and hours, instead of days or weeks.

Pump shafts • Impeller journals • Motor shafts
Rotor blades • Packing areas • Pump plungers

The list of metallizing users in the Petroleum field reads like a Blue Book of the industry. Here are just a few:

Cities Service Refining Co. — Ohio Oil Co.
Esso Standard Oil Co. — Phillips Petroleum Co.
Gulf Oil Co. — Socony-Vacuum Oil Co.
Imperial Oil Co. (Canada)

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Metallizing Engineering Co., Inc.
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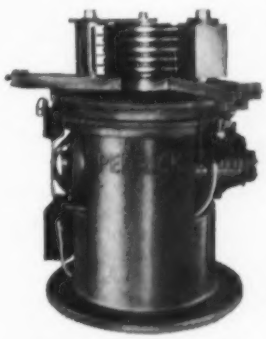
Let Pedrick show you how the latest methods of bending pipe, tube and structural metal—on a job or production basis—can save you money.

For full information on Pedrick Production Benders, write PEDRICK TOOL AND MACHINE CO., 3640 N. Lawrence St., Phila. 40, Pa. Dept. 13.



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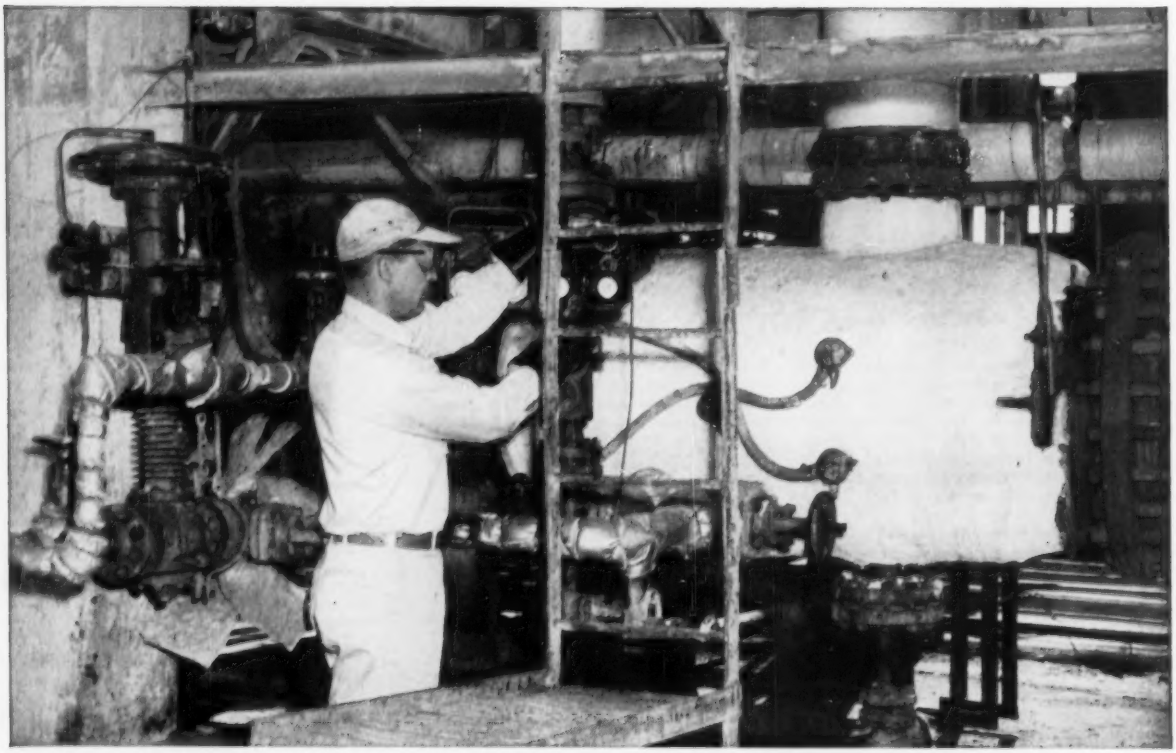


Still man checks soluble oil level in steam reboiler keg Monel-cladding of the shell, Monel in the tubes, and Monel trim on the large valve at left protect against corrosive attack of the high-temperature, aqueous HF stream.

After 13 years experience with HF alkylation, Phillips Petroleum finds that

...Monel prevents severe HF corrosion and promotes safety

In 1942, HF alkylation to produce aviation gas had "crash" priority. "Get the plant operating," was the word.

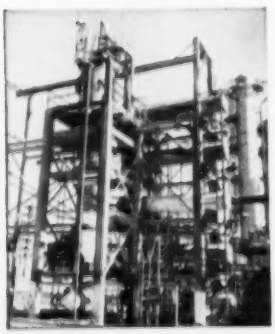
So Phillips Petroleum Company pioneered . . . built in accordance with the urgency of the times, then scheduled shutdowns at six-month intervals to check performance of materials.

What Phillips found

With high concentrations of HF at approximately atmospheric temperatures . . . and where moderate scaling can be tolerated . . . carbon steel is practical.

Where conditions are severest . . . where an extra margin of safety is needed . . . Monel® is the metal to use. With Monel in the key locations shown (see panel), Phillips has been able to stretch the interval between inspection shutdowns to two years.

Monel provides useful resistance to HF in all concentrations and (in unaerated solutions) up to 250° temperature. Raise this to 1100°F for the anhydrous acid, under certain conditions. What's more, Monel is comparatively unaffected by high stream velocities. It provides high strength and wear resistance.



Acid re-run unit regenerates HF to about 100%. See details above.

Key locations where Monel is used in Phillips HF alkylation plant at Phillips, Texas

In acid re-run unit, flash tower is constructed of Monel-Clad Steel, with Monel trays, caps and chimneys. Feed preheater contains a Monel-lined channel head and Monel tube bundle in overhead condenser and in the reboiler of the flash tower where a mixture of acid, water and oil is handled at 300°F.

Throughout the plant, critical valves, pumps and instruments are Monel or Monel trimmed. For safety, relief valves in acid-hydrocarbon service have Monel rupture discs and gaskets. Ring joint flanged acid service lines are fastened with "K"® Monel or Duranickel® stud bolts.

Are you having trouble with HF corrosion?
Write Corrosion Engineering Section,

THE INTERNATIONAL NICKEL COMPANY, INC.
67 Wall Street New York 5, N. Y.

INCO Nickel Alloys

Monel... *for minimum maintenance*

engineer and assistant to the president, and as plant manager just prior to joining Houdry.

Diamond Alkali Company has promoted **J. C. McKenna,** veteran sales executive, to the newly-created position of manager of soda products sales. Under his direction will fall the task of marketing Diamonds output of soda ash to all industries except glass.

Infilco, Inc., has formed an Australian subsidiary with offices in Sydney. This becomes Infilco's third foreign subsidiary, the other two being located in Mexico and Canada. A fourth subsidiary is in process of formation in Japan.

Stanley D. Heden has moved to Sydney to assist in the organization of the new subsidiary and to supervise its operation. Heden is a chemical engineer who has been associated with Infilco for seven years.

Norton Company has appointed **Bruce Cramer** as refractories engineer for Michigan and Indiana. Cramer, who has been serving in the same capacity in Texas since 1954, succeeds **David Bolon** who has resigned to start a private business venture on his own. Mr. Cramer joined Norton Company in 1952 and prior to going to Texas in 1954, was a member of the Sales Engineering department.

Cramer

The Dow Chemical Company has advanced **M. H. P. Morand** to the post of manager of coatings sales. He succeeds **Floyd J. Gunn** who has become manager of Dow's Los Angeles office.

Morand was promoted after serving since 1953 as assistant to the manager of coatings sales. His headquarters will be in Midland.

Joining Dow in 1949, Morand has also served on the company's coatings technical service staff and as a coatings salesman with the Chicago office.

Claud S. Gordon Company has added another office established by its Southwest distributor, Gay Sales Company. The new office is located in Dallas. Appointed as its manager is **B. B. McKroskey.**

Minneapolis-Honeywell has appointed **Vince Tassi** industrial manager for Hartford, Conn. and **Lyle Russell,** industrial manager for Chicago. Tassi, a 24-year veteran with the company formerly was in the New York sales office. Russell, a 10-year man, formerly had assignments in Boston and more recently was manager at Hartford.

Beckman Instruments, Inc., has added **David C. Kalbfell** to the consulting staff of its Berkeley division for work with special problems concerning digital information handling and high-frequency counting. A physicist and electronics instructor at San Diego State College, Kalbfell combines his teaching with presidency of a research and development firm, Kalbfell Electronix.

The Bird-Archer Company has made **C. W. Bird, Jr.,** its vice president. This will be in addition to his duties as general manager.

Joy Manufacturing Company has launched a new facility at Buffalo, N. Y. It is known as the Turbo-Dynamics division. The Buffalo organization's objective is the establishment of a major new division producing air and gas-handling devices. The new research and testing facility will point its activities toward laboratory development of prototypes and will establish designs for regular manufacture. Head of the Turbo-Dynamic laboratory is **L. Roy Krouse.** John D. Russell, engineering vice president of Joy provides top management direction.

SKF Industries, Inc., has appointed **William A. Sine, Jr.,** to the post of general supervisor of production material control and procurement. Sine has been a member of the purchasing staff at SKF for a number of years.

Suppliers . . .

U. S. Steel Corporation has appointed **Howard Cooper Johnson** as assistant to the chairman of the board. Johnson, who was with the Ford Foundation for three years before he joined U. S. Steel, has a varied background in industry and government.

Johnson started his business career with the investment banking firm of Stroud and Company in Philadelphia in 1934, and the following year joined the Lazard Freres & Company, Inc., in New York. In 1937, he became associated with Morgan Stanley & Company.

In 1941, he joined the Naval Material Inspection Administration. He was appointed assistant to secretary, Joint Chiefs of Staff in 1943 and a year later was

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Has soft arc action

Yet has equal penetration

WHY use anything but FLEETWELD 5-P for general purpose refinery welding

FLEETWELD 5-P

E-6010 all-position electrode

particularly suited for construction and maintenance of storage tanks . . . pipe welding vertical up or vertical down

gives you

- uniform, deep penetration
- flat bead shape
- easy slag control to eliminate surface holes
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Position_____

For more data on advertised products, use Readers' Service Cards, last page.

LUBRICATE PLUG VALVES
BETTER, SAFER,
AND AS MUCH AS
20-TO-1 FASTER

. . . . with
DELTA
GUNS and FITTINGS

By adapting the Delta-Desco System, one man can lubricate as many as TWENTY plug valves—while by the jack screw method a man can service only ONE. The Delta-Desco System is not only faster, but easier, safer, and more positive.

The lightweight Delta Gun offers many safety features, develops 10,000 lbs. and is tested to 30,000 lbs. pressure. Delta fittings for any lubricated plug valve, guaranteed not to leak under 15,000 lbs. pressure.

Write for catalog and prices.

The Only Complete Plug Valve Lubrication Company

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Sales Offices in All Principal Cities

DELTA-DESCO
PLUG VALVE
LUBRICANTS
AND EQUIPMENT

LUBRICANTS FITTINGS GUNS LUBRICATORS

Acquires Kansas Plant—

Rockwell Manufacturing Company has acquired the Locomotive Finished Materials Company plant at Atchison, Kansas. The plant, the largest steel foundry and machining facility west of the Mississippi River. It casts, machines and assembles a large volume of equipment for the petroleum industry as well as for a number of other industries.

assigned to the Office of the Secretary of the Navy. In 1945, he was a member of San Francisco Conference on the drafting of the United Nations organization.

From 1945 to 1951, Johnson served with the Office of United Nations Affairs, Department of State. Successively, he was assistant chief, Division of International Security Affairs, and chief from 1947 to 1949, and director of the United Nations Planning Staff from 1949 to 1951. Johnson attended the National War College of the Joint Chiefs of Staff from 1951 to 1952.

Columbia-Southern Chemical Corporation has established a new district sales office at Houston. Previously, the Houston area was serviced through a branch of the Dallas district office.

C. K. Ballard has been appointed sales manager for the Houston district. **W. J. Bramblett** will serve as assistant district sales manager at Houston.

Diamond Alkali Company has made appointments to fill six new managerial and administrative positions in its newly-formed Electro Chemicals division.

Wilburn J. Butler, assistant works manager at Diamond's Deer Park Plant at Houston for the past two years, becomes works manager.

Jack R. Horacek, assistant works manager at the Muscle Shoals Plant since November 1954, takes over the duties at Deer Park relinquished by Butler.

James H. Fall, Jr., for the past eight years superintendent of Diamond's Edgewood plant, succeeds Horacek at Muscle Shoals.

Edward I. Fogelman, assistant superintendent at Edgewood since mid-1954, moves up to superintendent, replacing Fall.

Ralph H. Parsons, presently inorganics chemicals production manager at Deer Park, becomes staff assistant to Chrencik, assisting him in coordinating the new division's electrolytic operations at five plants.

Ernest R. Sarrey, since 1948 a staff assistant in the controller's office at Cleveland, is now divisional administrative assistant.

Marlow Pumps Division of the Bell Gossett Company has named **Richard G. Bolling** as new district engineer in the Virginia-North Carolina area. He will make his headquarters at Greensboro, N. C. During the last seven years, Bolling was connected with Sears, Roebuck and Company and was manager of their territory engineering office covering North Carolina, South Carolina, and parts of West Virginia and Tennessee. He was in charge of all of the engineering work in that area.

Bolling

Payne Products International, Ltd., associated with The Crane Packing Company of Chicago, now is building the "Lapmaster" flat lapping machines in the United Kingdom and for certain overseas markets. The machines are being built by The Coventry Gauge & Tool Co., Ltd. who will also handle sales in Great Britain.

These machines incorporate a self-conditioning, automatic control cycle and are available in sizes from 12 inches to 84 inches lap diameter. The machines are especially suitable for refinery shop maintenance of mechanical seal faces and similar applications where flat and high-quality finishes are required.

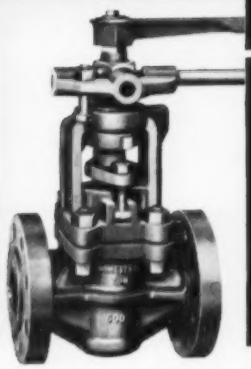
Laclede-Christi Division, H. K. Porter Company, Inc. has appointed **Rex D. Cross** to the newly created position of vice-president in charge of sales.

Cross joins the Porter organization after several years as an independent management consultant in Los Angeles. Earlier, he was general sales manager of the Johnston Pump Company, now a part of Youngstown Sheet and Tube Company.

Koppers Company, Inc. has arranged to take over the marketing of textile dyes which have been made and sold by Pittsburgh Coke & Chemical Company. Pittsburgh Coke & Chemical will discontinue

if your problem is...

- TEMPERATURE
- PRESSURE
- CORROSION...



HOMESTEAD
Lever-Seald
PLUG VALVES
will solve it...

Conditions which cause ordinary valves to fail --corrosive, erosive, viscous, or volatile hard-to-hold fluids, plus temperature or pressure extremes --are everyday jobs for Homestead Lever-Seald Valves. Why? Because they *are built to operate under all conditions!* They never stick!

Every Homestead Lever-Seald Plug Valve has a powerful lever and screw device that does double duty. It presses the tapered plug firmly into its seat to form a drop-tight seal, and also provides a positive means to relieve seating pressure and permit easy operation.

Lever-Seald Homestead Valves give extra long, leak-proof service, too, because all operating parts and seating surfaces are protected from line fluids in both the open and closed positions. You can prove their economy to your own satisfaction, by making your next replacement a Homestead Lever-Seald.

Your choice can be made from valves cast of metals and alloys to specification in sizes from 1″ to 12″; for pressures from vacuum to 1500 pounds; temperatures from 40° below zero to 1100°F. Dry seat or pressure gun lubricated optional.

You'll find our VALVE REFERENCE BOOK No. 39-3 interesting and helpful. It's yours for the asking.

MAIL THE COUPON TODAY!

Without obligation, send me Valve Reference Book No. 39-3 describing Homestead Lever-Seald Plug Valves.

Name _____ Title _____

Company _____

Address _____

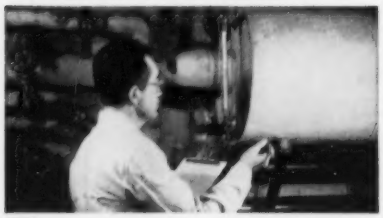
City _____ State _____

HOMESTEAD VALVE MANUFACTURING COMPANY

P. O. BOX 45 "Serving Since 1892" CORAOPOLIS, PA.

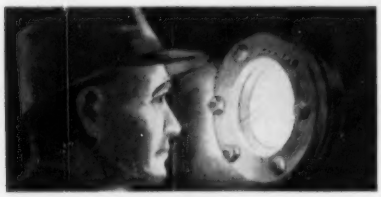
For more data on advertised products, use Readers' Service Cards, last page.

☑ *what* do you want to see?



☐ **WATER LEVEL?**

Pressures to 100 p.s.i.—CORNING brand STANDARD gauge glasses. To 300 p.s.i., and high temperatures—PYREX brand HIGH-PRESSURE gauge glasses. To 300 p.s.i., and corrosive conditions—PYREX brand HEAVY-WALL gauge glasses. For greater visibility—PYREX brand RED-LINE gauge glasses. 350 to 5000 p.s.i. (and higher in some cases)—MACBETH brand FLAT gauge glasses.



☐ **INTO HIGH-PRESSURE, HIGH-TEMPERATURE VESSELS?**

PYREX brand SIGHT GLASSES give you typical advantages of PYREX brand glass No. 7740—high thermal shock resistance, chemical stability, physical stamina, clear visibility, resistance to clouding.

☐ **LUBRICATION LEVELS, OIL LEVELS?**

PYREX brand lubrication and oil-cup glasses—long-lasting, chip-resistant, easy to install. Accurate dimensions insure a snug fit.

Your Industrial Distributor has a complete line of Corning quality gauge glasses—let him help you select the types which will best serve your needs. Call him today.

CORNING INDUSTRIAL GLASSWARE FOR EVERY JOB

Application	*Recommended Product*
Normal Conditions (Up to 100 p.s.i.)	CORNING brand standard gauge glasses
Higher temperatures	PYREX brand high-pressure gauge glasses
Higher pressures	PYREX brand heavy-wall gauge glasses
Extra visibility	PYREX brand red-line gauge glasses
Viewing inside furnaces, reactors pressure vessels, etc.	PYREX brand sight glasses
Lubrication Inspection	PYREX brand lubricator glasses
Visible discharge devices	PYREX brand oil cup glasses

CORNING GLASS WORKS
Corning, New York

Corning means research in Glass

Suppliers . . .

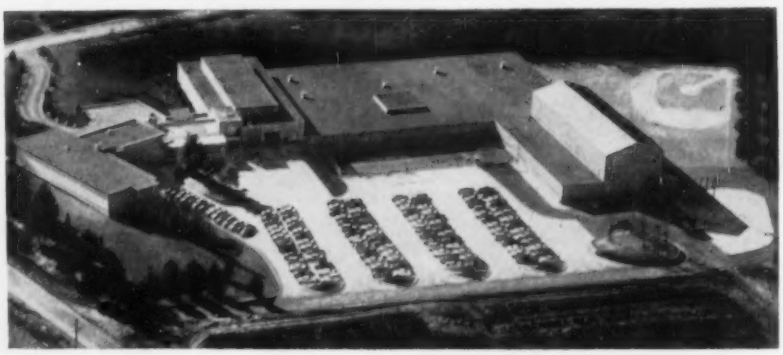
the direct marketing of dyes. The eight-member sales staff of that company which has been assigned to sales of dyes will join Koppers wholly-owned subsidiary, American Aniline Products, Inc., which has its plant at Lock Haven, Pa.

Under terms of the agreement, Koppers acquires the textile dye business of Pittsburgh Coke & Chemical, exclusive of its manufacturing facilities in that field.

Hooker Electrochemical Company has elected two new vice presidents. **Thomas E. Moffitt** has been elected executive vice president and a director and **R. Wolcott Hooker** has been elected senior vice president.

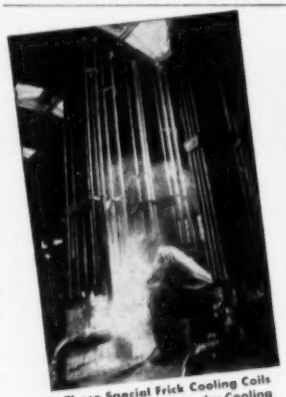
Moffitt has been vice president in charge of western operations of Hooker, with his headquarters at Tacoma, Wash. He has been vice president, director, and a member of the finance committee at the company's headquarters office in Niagara Falls.

Hooker became a salesman in the Small Package division in 1922 and later transferred to selling bulk chemicals. He became assistant sales manager in 1935, a director in 1937, vice president in charge of sales in 1941, and in 1953 he was

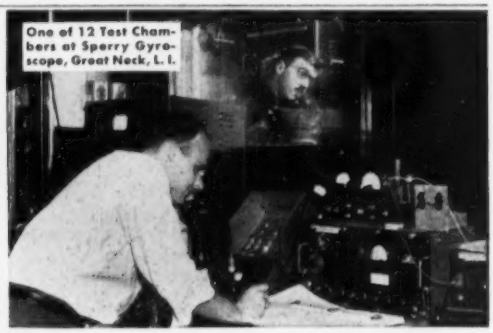


Opens Philadelphia Plant—

Selas Corporation of America has moved from its Philadelphia site to a new multi-million-dollar plant in the suburbs. The new plant, on an 11-acre site north of Philadelphia, has been developed to provide fully-coordinated facilities for all the company's activities. All research and development work is concentrated in one building, except for the ceramics laboratory which is in the manufacturing area. The manufacturing building, containing all production equipment, adjoins the laboratory.



These Special Frick Cooling Coils Are Making History by Cooling Synthetic Rubber Twice as Fast



One of 12 Test Chambers at Sperry Gyroscope, Great Neck, L. I.

Need a SPECIAL Cooling System?

Orange Juice is Concentrated with Frick Reversed Refrigeration at 1/10th the Cost of Steam.

Then the chances are that Frick engineering and production facilities can serve you.

We specialize in custom-built refrigerating and air conditioning equipment: our engineers, designers, foundrymen and mechanics team up to handle those unique jobs which other manufacturers hesitate to accept.

We just furnished, for example, a 25-foot shell, over 7 feet in diameter, with complete equipment for conditioning air at 100 pounds pressure for a huge wind tunnel.

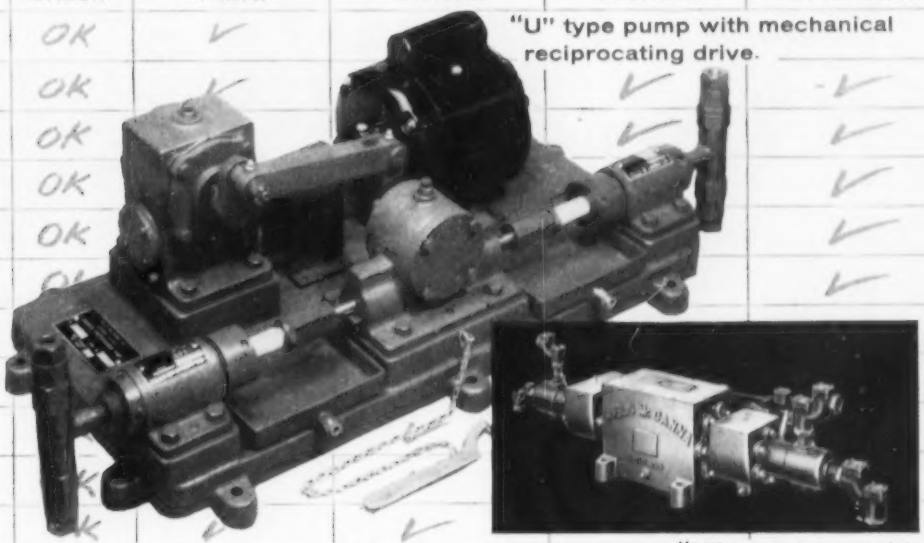
Tell us what you need—we'll do the rest! Branches and Distributors in principal cities, the world over. Write

DEPENDABLE REFRIGERATION SINCE 1882
FRICK CO.
WAYNESBORO, PENNA. U.S.A.

Why the FIRST COST is the LAST COST with HILLS-McCANNA METERING PUMPS

PUMP MAINTENANCE REPORT

MONTH	CHECK VALVE	STROKE	PLUNGER	LUBRICATION
JANUARY	OK ✓			
FEBRUARY	OK ✓		✓	✓
MARCH	OK		✓	✓
APRIL	OK			✓
MAY	OK			✓
JUNE	OK			✓
JULY				
AUGUST				
SEPTEMBER				
OCTOBER	K			
NOVEMBER	K	✓	✓	
DECEMBER	OK	✓	✓	✓



"U" type pump with mechanical reciprocating drive.

"K" type pump with hydraulic drive.

HILLS-McCANNA dependability pays off in lower maintenance . . . longer life . . . greater accuracy . . . cost-saving versatility

Maintenance reports from the leaders in many different industries prove the low-cost operation of Hills-McCanna metering and proportioning pumps . . . tell why these pumps are specified for installations requiring the finest equipment. Part replacement is remarkably low because there are few points of wear. Routine maintenance is simple and economical thanks to special Hills-McCanna features, such as separate interchangeable check valves and easy, precise stroke adjustment (even while in operation when desired). Working parts are completely enclosed to keep them dirt-free. All U Type pump bodies are interchangeable in the housing for quick convertibility. Straight reciprocal drive eliminates bushing replacement. And, you'll find Hills-McCanna pumps mighty easy to install.

If you must continuously meter or proportion small volume flows with great accuracy, you'll want to consider the "U" type pump—available in 1, 2, 3 and 4 feed units. The "K" type pump —also available in 1, 2, 3 or 4 feed units—will meet your larger flow requirements.

Hills-McCanna can furnish a pump to meet *every* type of installation . . . with a wide choice of corrosion, wear and abrasion-resistant liquid ends . . . in capacities and pressures for every need.

Write for full facts now. You'll be dollars ahead tomorrow by investigating today!

A dependable NEW HEART to put NEW LIFE into your chemical metering system!

HILLS-McCANNA COMPANY

3025 N. Western Avenue, Chicago 18, Illinois

metering and proportioning pumps

also manufacturers of: FORCE FEED LUBRICATORS • DIAPHRAGM VALVES
MAGNESIUM ALLOY SAND CASTINGS

For more data on advertised products, use Readers' Service Cards, last page.

ERNST
HIGH PRESSURE GLASSES and GASKETS

All sizes to fit your gages and valves

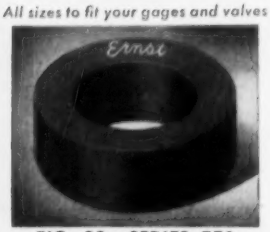


FIG. 22 SERIES 750

FIG. 21 LIP-MOLD

STATE YOUR REQUIREMENTS

All shipments from stock.
Send for Catalog

ERNST WATER COLUMN & GAGE CO.
Livingston 6-1400 LIVINGSTON, N. J.

Suppliers . . .

made vice president responsible for purchasing and public relations. He is also a director of Hooker Chemicals Ltd. and Marble-Nye Co., wholly-owned subsidiary.

Garrison

Avinger

Armour and Company has appointed sales representatives in two new regional offices.

Robert Avinger will handle sales of Armour chemicals in West Texas and New Mexico, while Lester Garrison will cover the Southeast section of the country.

Avinger is a chemical engineer with three years experience as a petroleum engineer. He will have headquarters at Midland, Texas.

Garrison has been in sales training at the Armour Chemical Division for a year. Prior to that he was in the Air Force in Germany. His new headquarters will be at Charlotte, N. C.

Rockwell Manufacturing Company has acquired the assets of Locomotive Finished Materials Company of Atchison, Kansas. The 84-year-old Kansas concern—also known as LFM Company—is the largest Rockwell acquisition since the purchase of Delta Manufacturing Company of Milwaukee eleven years ago. It will continue under its present management as a major division of Rockwell.

The International Nickel Company has added **Michael C. McFadden, Jr.,** to the Central Atlantic Coast Technical Field section of the Development and Research division. The section headquarters are in Abington, Pa.

Before joining Inco, McFadden for more than six years was associated with the Chevrolet-Detroit Gear and Axle division of General Motors Corporation at Detroit, attaining the position of supervisor in the Plant Engineering department.

He served two years at the U. S. Naval Proving Ground at Dahlgren, Va., as a test officer in the Special Projects division of the Terminal Ballistics department.

Alan Wood Steel Company has appointed **T. D. Owens** as manager of foundry coke and pig iron sales, and made **W. J. Patterson** manager of industrial coke and chemical sales.

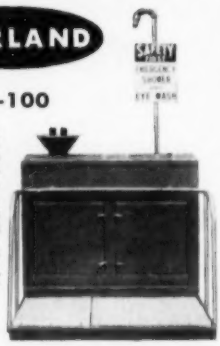
Ansul Chemical Company employees, for the second year in a row, have chalked up a perfect safety record, earning an extra day's pay.

The last lost-time accident in the plant occurred November 24, 1953. Since then, the 239 hourly plant employees have

EMERGENCY
SAFETY SHOWERS
by **MORLAND**

MODEL CO-100

Combination overhead shower and eye bubbler independently activated by aluminum platform treadles. Cabinet houses all piping. Steam or electric heat. Doors front or back.



MODEL SO-101

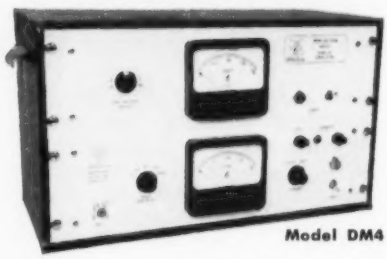
Safety Shower unit operated by platform grating. Non freezing type. (See Inset, opposite.) Overhead light for night identification.

Other Morland Specialties:
Figure "8" Blinds, Temporary Strainers, Retractable Spray Nozzle Assemblies

write for complete details:

MORLAND ASSOCIATES
100 QUIMBY STREET • WESTFIELD, N. J.

20,000 counts per minute Counting Rate Meter



Model DM4

The DM4 is a linear counting rate meter consisting of our Model DM1 Count Rate unit and Model DV1 High Voltage Supply, that has a maximum counting rate of 20,000 counts per minute and high voltage range of 550 to 2000 volts positive. (The count rate unit section may be ordered separately if high voltage supply is not required). The DM4 Counting Rate Meter has connectors in the rear for a recorder driving other instruments in series or parallel, and a connector for a scintillation probe or preamplifier.

Sales Offices

Electro-Mec Associates
109 E. Nine Mile Rd.
Ferndale 20, Mich.
Phone LIncoln 7-1422

Kimball Electronics, Ltd.
209 Alhambra Circle
Coral Gables, Fla.
Phone 4-9028

Export Sales

Borg-Warner International, 36 S. Wabash Ave.
Chicago 3, Illinois U.S.A. Cable Address—BORINTCO

detectolab, Inc.
6544 N. Sheridan Rd., Chicago 26, Ill.
an affiliate of Borg-Warner Corporation

F&P Flowmeters

FROM
HATBORO, HOUSTON, CHICAGO OR LOS ANGELES

Predictable performance floats permit Flowrator Meters with true percentage scales to be carried in stock. You benefit from F&P's years of hydraulic research by getting accurate meters quickly.

Greater flexibility of use is assured by the ease and simplicity with which new flow factors may be determined on changes in fluid service. Capacity may also be altered by revising metering float weight and yet, the same metering accuracy is maintained.

Advantages of specifying F & P Meters:

- Highest quality—same as made-to-order, extended shipment instruments.
- Prompt delivery—most items shipped the same day the order is received.
- Economy—standardization on percentage scales and interchangeable parts, minimizes spare part problems.

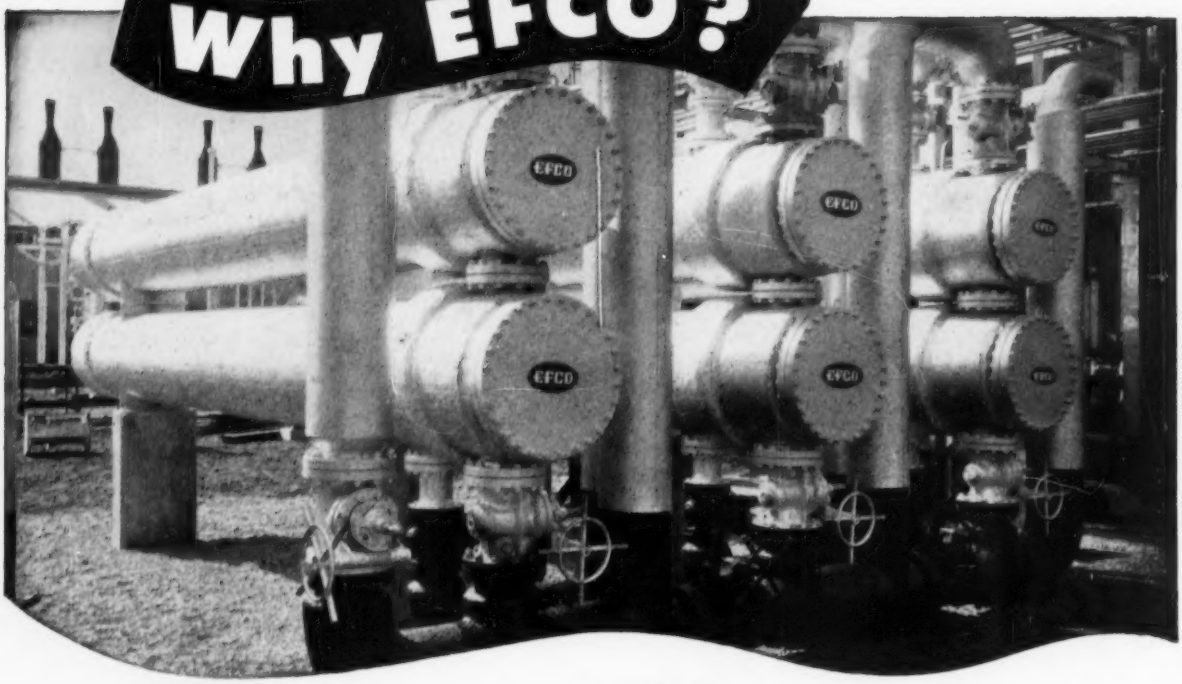
A wide variety of flow indicators, purgemeters, transmitters, recorders, controllers and pressure instruments are available from stock. Write today for Catalog #2 and complete information.

FP FISCHER & PORTER CO.

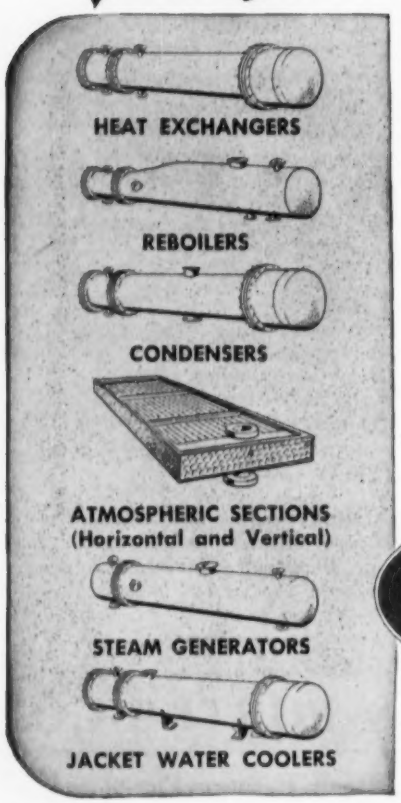
936 County Line Road, Hatboro, Penna.

LA1059

Why EFCO?



Performance is the answer!

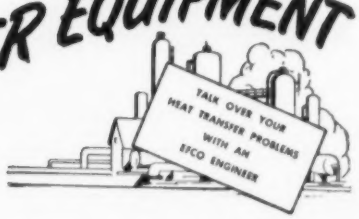


With the installation of EFCO heat transfer units in your plant, you will be sure of getting *guaranteed performance* with the extra advantages of low maintenance cost, high operating efficiency, long life and freedom from leaks.

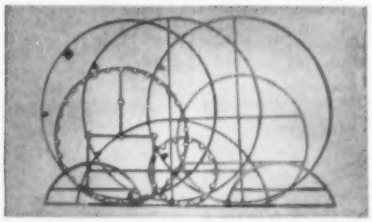
Talk over your heat transfer problems with an EFCO engineer. He will tell you about EFCO installations that have successfully solved problems similar to yours and explain how EFCO equipment will give you the performance you want.

ENGINEERS & FABRICATORS, INC.
P. O. Box 7395 Houston 8, Texas

EFCO HEAT TRANSFER EQUIPMENT



Need GASKETS for HEAT EXCHANGERS?



Call CHICAGO-WILCOX for PROMPT DELIVERY

Here is a dependable source for gaskets for heat exchangers. These gaskets can be made in any size or shape as needed—cut from solid metal, sheet-packing; also double jacket type.

Send specifications, blue prints or templates, for quotation and a prompt-delivery schedule for normal stocking orders.

CHICAGO-WILCOX MFG. CO.
7703 Avalon Avenue, Chicago 19, Ill.
Phone: SAginaw 1-1900

See Page 257 in Refinery Catalog

DON'T THROW AWAY BROKEN or CRACKED CASTINGS!

JUST CALL **YEL-O-WELD**
REG. U. S. PATENT OFFICE
AMERICA'S NO. 1 PROCESS

3 TIMES STRONGER than the ORIGINAL Cast Iron

All Work Unconditionally Guaranteed

A special process that produces a GUARANTEED weld, without pre-heating or heat distortion!

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CASTING REPAIR SERVICE
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2746 S.W. 29TH ST — OKLAHOMA CITY, OKLA.

Suppliers . . .

worked 1,904,743 man hours without a lost-time accident. Safety is stressed throughout the year by means of posters and other reminders.

De Laval Steam Turbine Company has named **W. H. Mouquin** as its district manager in Chicago, and appointed **C. C. Bray** as regional sales supervisor in the same office.

Fox Silver Gray

The Pfaudler Company has promoted **Alton L. Gray** to assistant general sales manager. At the same time, **Edgar N. Fox, Jr.**, was named Rochester district sales manager, replacing Gray. **Robert C. Silver** was promoted to field sales engineer replacing Fox in the Rochester-Niagara frontier district.

Gray has been with the company since 1922. After several years in the Engineering department and many years as a field salesman, he was named Rochester district sales manager in 1949.

Fox, with the company since 1937, will supervise field salesmen extending from Canada to Tennessee, excepting New England and metropolitan New York. Silver joined the Advertising department of the company in 1951 and has been a member of the sales staff organization.

Payne Products International Ltd., has added **L. P. Hulin** to its staff. The company, headquartered at Hounslow, Middlesex, England, is a subsidiary of Crane Packing Company. Hulin, known as "Speedy," is a transplanted American. He formerly was process pump sales manager for Hayward Tyler Company, Ltd., a Luton, England, firm.

Hulin

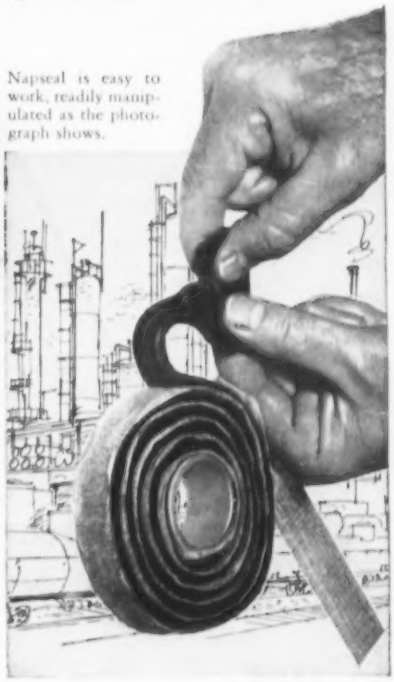
Reynolds Metals Company has concluded the first national distribution agreement between an aluminum producer and a major oil country distributor. The agreement was made with The National Supply Company, of Pittsburgh.

The firm will market Reynolds aluminum oil country pipe and well also stock aluminum couplers and fittings, enabling their stores to supply complete aluminum pipeline systems.

Atlas Powder Company has appointed **E. John Caruso** as assistant manager of its Chemicals division regional sales office in Chicago. Formerly technical

NEW sealing compound resists gasoline and oil...

Napseal is easy to work, readily manipulated as the photograph shows.



J-M NAPSEAL

Napseal is the compound for those difficult sealing jobs where exposure to oils and fuels (including aviation gasoline) is encountered. Highly adhesive, it holds a tight seal, remaining permanently plastic in the presence of petroleum derivatives. Napseal retains its water tightness, will not dry out in service.

Napseal is easy to work and remains workable over a wide temperature range. It will not corrode metals or cause the deterioration of common substances in contact. Neither will it stain.

Napseal is handy for emergencies and other sealing needs. It requires no mixing, comes ready to use in beads, ribbons and 3″ diameter pugs. Data sheet EL-64A gives more information. Write Johns-Manville, Box 60, New York 16, N. Y. In Canada, Port Credit, Ontario.

JM

Johns-Manville SEALING COMPOUNDS

For more data on advertised products, use Readers' Service Cards, last page.

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peak performance
INTO YOUR
compressors
(AIR • GAS • AMMONIA)

Peak performance, maximum efficiency, greater output, and lower power costs can be built into your oldest, and of course your newest, compressors by the installation of VOSS VALVES.

Check THESE
VOSS VALVE ADVANTAGES:

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- 20 to 60% more valve area
- less power consumption
- minimum pressure loss
- normal discharge temperature
- lower operating costs
- utmost safety

Our detailed proposal for increasing the efficiency of your compressor will be sent you without obligation. Send us the name, bore, stroke, and speed of your machine.

J. H. H. VOSS VALVES
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"How To Get Those Top Octanes"

Now available in reprint form, this article by Marshall Sittig and Wayne Warren of the Ethyl Corp., appeared in the September, 1955, Process Issue of PETROLEUM REFINER.

Presented is a thorough treatment of octane improvement techniques, plus a most authoritative and up to date comparison of catalytic reforming processes. Here is a comprehensive, 50-page monograph that should be in every process man's reference file.

Available for only $1.00 per copy, this reprint can be obtained by addressing:

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Suppliers . . .

representative in the company's St. Louis, Mo., sales office, Caruso will serve in the newly-created post as assistant to the manager of the Chicago office.

Paul E. Stubble, technical representative in Atlas' chemical sales office in Dallas, Texas, has been transferred to St. Louis to succeed Caruso.

Markley

Deal

The Timken Roller Bearing Company has named **H. E. Markley**, former secretary of the company, to a post as assistant to the president. **George L. Deal**, who was treasurer, will serve both as treasurer and secretary.

Markley joined the company in 1938 as an accounting trainee. He was successively steel-cost supervisor, assistant and chief cost accountant and assistant secretary. He was elected secretary in mid-1953.

Deal joined Timken in 1936 and in 1942 was named treasurer of Timken Ordinance Company. This company was dissolved two years later and he became manager of contract terminations. He was made assistant treasurer in 1947 and in 1953 became treasurer.

Taylor Instrument Company has named **Frank S. Ward**, general sales manager, to the board of directors. He was also elected a member of the executive committee. Also elected to this committee for the first time were two fellow directors; **Marc E. Porter**, assistant treasurer and **Karl H. Hubbard**, technical director.

Ward

Ward's career with Taylor began in 1917 in the Order department at Rochester. Before moving to Boston in 1922 as a salesman and later manager of that office, he served in the Industrial Thermometer division. In 1936 he handled sales to the canning, rubber and textile industries. From 1945 to 1951 he was industrial sales manager. When **Raymond E. Olson**, former general sales manager, assumed the presidency in 1951, Ward was named to his present post.

Carrier Corporation has appointed **Herbert E. Miller** as branch manager for the Washington, D. C. office of its Unitary Equipment division.

Miller's first assignment with Carrier was as student engineer in the dealer sales service department, Chicago district office. In 1948, he was named district service supervisor in the Jackson, Miss., area, sub-

For more data on advertised products, use Readers' Service Cards, last page.

caustic soda—

which strength should you buy?

Here are the facts to help you decide which saves you more—50% or 73%

Can you save by switching from 50 to 73% liquid caustic? Your answer will depend on:

1. Your caustic soda freight rate.
2. Your facilities for handling caustic.
3. The amount of caustic you use.

Advantages of 73% liquid

1. With 73%, there is a substantial saving in freight charges. 63% less water is shipped per unit weight of dry caustic soda.
2. You will place fewer orders. This cuts down on your billing work.

Disadvantages of 73% liquid

1. It is priced $2.00 more per ton (dry basis) than 50% because of higher manufacturing costs.
2. If you store it as 73% liquid, you will need heated, nickel-clad steel storage tanks.
3. If you dilute 73% to 50% while unloading, you will need a cooler and other equipment. This represents a considerable investment which can be reduced if you have suitable equipment already on hand.

Use this table to see if you can save with 73%

Use the table at right to find your approximate saving on freight charges with 73% liquid caustic. The table balances two cost factors . . . lower freight charges and the higher initial price of 73% liquid caustic.

To estimate your yearly savings, multiply the figure in the right-hand column which applies to you by your annual consumption in tons (dry basis).

From these savings you will have to deduct the cost of equipment for diluting to 50% while unloading.

Freight rate per hundred weight in cents (including taxes)	*Net savings per ton (dry basis) in dollars*
5	minus 1.40
10	minus .80
15	minus .10
16	0
20	.60
25	1.20
30	1.80
35	2.40
40	3.00
45	3.70

HERE'S HELP—WITHOUT COST

You gain much by choosing the *right* strength for your conditions. In coming to a decision, why not give yourself the advantage of unbiased expert technical help? A call to your nearest Hooker sales office puts at your disposal, without obligation, the experience gained in 50 years of supplying caustic soda to industry.

Your Hooker technical service man can show you what equipment you need for converting, and help you figure your exact savings. Why not phone or write him today at the nearest Hooker office?

* * *

"CAUSTIC SODA BUYER'S GUIDE" is the title of a new pocket-size booklet we will be glad to send you. Contains helpful facts on the economics of 50% and 73% solutions; other forms of caustic soda; capacities of tank cars and other containers; useful shipping information. Write for a copy.

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From the Salt of the Earth

HOOKER ELECTROCHEMICAL COMPANY

52 Forty-seventh Street, Niagara Falls, N. Y.

NIAGARA FALLS • TACOMA • MONTAGUE, MICH. • NEW YORK • CHICAGO • LOS ANGELES

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PNEUMATICALLY PLACED CONCRETE AND REFRACTORIES FOR

SUSPENDED WALLS ARCHES FOR PRESSURE VESSEL LININGS HEATERS • BOILERS

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Write for estimates on your proposed project.

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STEEL PIPE and TUBING

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- CHROME MOLY
- STAINLESS
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ALL SPECIFICATIONS – ANY SIZE

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sequently serving in the same capacity at Carrier's New York and Philadelphia district offices.

Prior to his new appointment, Miller was sales specialist in applied equipment for the Philadelphia district.

Tullo

Tribble

Worthington Corporation has elected two new vice presidents. They are **Elston J. Tribble** and **Aloysius M. Tullo.**

Tribble, former assistant vice president for manufacturing, will have general supervision of a group of Worthington operating divisions which recently were reorganized. Tullo will continue as general manager of the company's largest division, at Harrison, N. J.

Tullo joined the company in 1929. He was appointed production manager in 1935, assistant works manager of the Harrison works in 1942 and works manager in 1945. He had been assistant vice president since 1954.

Tullo started with the company in 1923 and became manufacturing engineer in 1939. He was made assistant works manager at Harrison in 1945, and received an appointment as manager there in 1954. He was made general manager of the Harrison division in 1955.

Rockwell Manufacturing Company has made **A. Clark Daugherty,** former market research manager, assistant to the president. The Market Research, Public Relations and Stockholder Information departments will continue to report to Daugherty, who has been assigned additional managerial functions.

Daugherty

Daugherty joined Rockwell in 1946 and became market analyst the following year. He was named manager of market research in 1951 and in 1953, received the additional duties of manager of public relations.

INFILCO, Inc., has appointed **George W. Paulette** as manager of its Municipal Sales division. He succeeds **Preston Pew,** who retires for full-time activity with the company after 31 years of service.

Paulette has 24 years experience with the company as a district and field engineer at Kansas City, New Orleans, Cleveland and Orlando. He will be stationed at the company's home office in Tulsa.

Pew will continue with the company as a consultant on a part-time basis. At various times he has been purchasing agent, factory manager and division manager.

TO REPAIR PIPE LEAKS – QUICKLY, PERMANENTLY

ANY PRESSURE – ANY TEMPERATURE

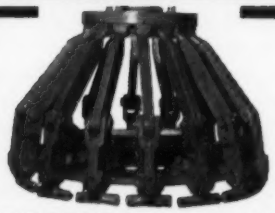
SKINNER-SEAL EMERGENCY PIPE CLAMP for pinhole or corrosion leaks.

SKINNER-SEAL PIPE LINE CLAMP for long splits and bad corrosion leaks.

In stock – all supply stores

M. B. SKINNER COMPANY

SOUTH BEND 21, INDIANA, U. S. A.



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for handling greases and other viscous fluids.

- No operator required.
- 100% air operated.

Fills, seals, stamps and counts lug cover pails. Output of 15 pails per minute. Write for details on installation to meet your requirements.

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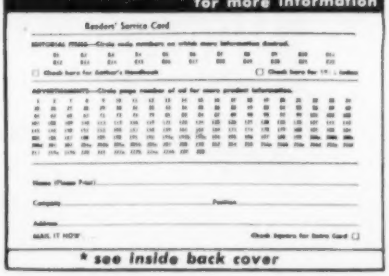


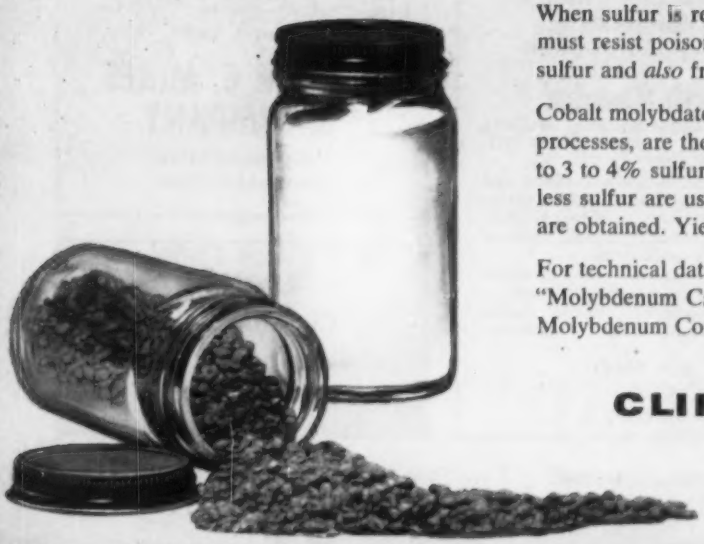
Readers' Service Card

* see inside back cover

Use the moly key
... to better catalysts

- Selective
- Resistant to poisoning
- Highly active
- Economical

Moly catalysts resist poisoning



When sulfur is removed from petroleum stocks, the catalyst must resist poisoning. It must withstand contamination from sulfur and *also* from nitrogen and metallic contaminants.

Cobalt molybdate catalysts, in a number of different commercial processes, are the answer to these difficult specifications. Stocks up to 3 to 4% sulfur by weight have been processed. When stocks with less sulfur are used, products containing as little as 0.1% sulfur are obtained. Yields are almost 100% of theoretical.

For technical data about molybdenum catalysts write for our bulletin "Molybdenum Catalysts for Industrial Processes." Dept. 25, Climax Molybdenum Company, 500 Fifth Avenue, New York 36, N. Y.

CLIMAX MOLYBDENUM

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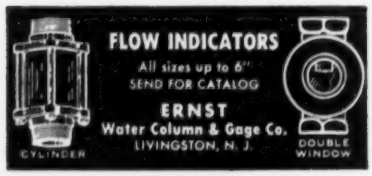

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Must be capable of performing general refinery engineering work and aid in development of design specifications for refinery processing equipment.

Duties will be closely integrated with operations of new independent refinery which includes crude distillation, catalytic cracking, polymerization, coking and utilities.

Send complete resume of education and experience, including salary requirements. All replies confidential.

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EMULSION PLANT SUPERVISOR

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Graduate engineers with minimum 5 years' experience in design or inspection of petroleum processing plants and equipment. Major part of experience must have been in inspection work entailing general knowledge of all facilities. Develop inspection methods, supervise and conduct inspections and advise operations on codes and equipment limitations in a major oil installation located in Saudi Arabia.

Write giving full particulars regarding personal history and work experience. Please include your telephone number.

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Must be thoroughly qualified and experienced in design and/or maintenance of refinery or chemical plant equipment including piping, pressure vessels, heat exchangers.

Attractive salaries, liberal annuity and savings program offered.

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World-wide McKee operation offers you a broad field in the design of Petroleum Refineries, Chemical Plants, Blast Furnaces, Steel Plants, Sintering Plants and Industrial Plants.

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a continuous flow of diversified, original assignments

New products with new problems are continually under development at DU PONT—it is our Design Engineers who find successful solutions for the commercial production of these products. Assignments are stimulating, different, difficult—not repetitive.

If you are a talented graduate engineer with 4 or more years design experience, DU PONT has opportunity for you. Consider this vital fact—our policy is promotion from within.

apply today to fill one of the immediate openings for

PROCESS AND EQUIPMENT DESIGNER-ENGINEER

Successful applicants will be capable, either now or with training, of translating research data into workable equipment and process designs. Will enjoy and have ability to work as a part of an engineering design team. Will be capable of handling field design problems which will involve working with shop or construction people. Experience in the design of processes or process equipment for chemical, petroleum, food processing and allied industries, knowledge of ASME Code For Unfired Pressure Vessels, and shop fabrication or piping design practice is helpful but not essential.

Applicants selected will make independent analysis, exercise individual judgment and coordinate the work of others while engineering and designing process equipment including tanks, vessels, distillation columns and machines. Equipment arrangements and piping work will also be included. Assignments are challenging and creative with full recognition for achievement.

Please send complete resume to:

Mr. T. J. Donovan
Engineering Department

E. I. du Pont de Nemours & Co., Inc.
Wilmington 98,
Delaware

HELP WANTED

UTILITIES SUPERVISOR

Graduate Mechanical Engineer with minimum of five years experience in the power field, and preferably with some electrical experience.

Specific duties will involve supervision of boiler plant operation, plant and instrument air systems, cooling towers and water distribution systems.

Working background required in process instrumentation and maintenance of electrical distribution and equipment.

Send complete resume of education and experience, including salary requirements. All replies confidential.

GREAT NORTHERN OIL COMPANY
P. O. Box 3596
SAINT PAUL 1, MINNESOTA

HELP WANTED

CHEMICAL ENGINEER

Research and Development Dept. of a Major Oil Co. located in Orange County in Southern California, has an immediate position available for an engineer with 2-4 years experience in petroleum or chemical process design. Excellent opportunity for a permanent position in a new and expanding organization performing work on design and development of petroleum and petro-chemical processes.

Submit letter resume of personal data, education, experience and salary requirements. All inquiries will be considered promptly and held confidential. Address reply to Employment Section of:

Richfield Oil Corp.
555 S. Flower Street
LOS ANGELES, CALIFORNIA

UNUSUAL OPPORTUNITY FOR TOP REFINING EXECUTIVE

If you already have a good top executive job in the refining industry but want to further improve your future with a large fully-integrated mid-western oil company—*this may be the most important advertisement you ever read!*

A proven ability to manage and operate a progressive and aggressive refining program including the manufacture of gasolines, lubricating oils and waxes is required . . . a technically trained man with considerable practical operating experience would be ideal . . . abilities in personnel management of more than 1,500 employees is essential. You and your family will enjoy living in one of the most metropolitan cities in the south-west.

If you are this executive, between the ages of 45 and 50, interested in a vice-president's status (you may be one now—and we hope so), a liberal stock option arrangement in a large fully-integrated company which is still growing, and a salary commensurate with abilities and production results—*it will profit you to write today for appointment interview.*

Box 226-R
PETROLEUM REFINER
Houston, Texas

For more data on advertised products, use Readers' Service Cards, last page.

HELP WANTED

HELP WANTED

HELP WANTED

PATENTS

1. Patent attorney with sufficient experience in chemical applications to work with minimum supervision in preparing and prosecuting applications before the Patent Office and proceedings in which they may become involved.
2. Chemist or chemical engineer with at least BS, recent graduate, as trainee in patent division. Night law school available with generous company contributions towards law school courses.
3. Chemist with some research background for work with research division in liaison with patent attorneys. Some experience in this area essential, and preferably in the petroleum industry.

THE STANDARD OIL CO. (Ohio)
Reply to E. G. GLASS, JR., 1737 Midland Bldg.
Cleveland 15, Ohio

REFINERY EQUIPMENT INSPECTOR

Man with minimum of five years experience in maintenance and inspection of mechanical equipment, three of which must be in a modern oil refinery or petrochemical plant.

Must have thorough knowledge of engines, refinery processing units, theory of stresses and causes, and control of corrosion.

Duties will include the inspection of mechanical condition of all tanks and vessels, pipe lines and fittings, processing units, pumping units, heavy mechanical equipment, and fire fighting equipment.

Send complete resume of education and experience, including salary requirements. All replies confidential.

GREAT NORTHERN OIL COMPANY
P. O. Box 3596
SAINT PAUL 1, MINNESOTA

AREA MAINTENANCE SUPERVISOR

Man with Mechanical Engineering degree and with minimum of five years of responsible experience in refinery maintenance or construction.

Will assist maintenance supervisor of new independent refinery in the direction of all maintenance activities on assigned process units.

Must be capable of determining the best methods of performing these activities through the use of proper tools and equipment and through coordination with other departments.

Send complete resume of education and experience, including salary requirements. All replies confidential.

GREAT NORTHERN OIL COMPANY
P. O. Box 3596
SAINT PAUL 1, MINNESOTA

PROCESS ENGINEERS

CAREER OPPORTUNITIES IN
SOUTHERN CALIFORNIA

•

for men with a minimum of five years' experience in PROCESS DESIGN for Petroleum or Chemical plants.

•

OFFERING MAXIMUM OPPORTUNITIES FOR:

Utilization & recognition of individual initiative & ability.

Broad responsibilities rather than narrow specialization.

Experience with a wide range of processes.

•

LIBERAL SALARY RANGES, PROFIT SHARING, TOP BENEFITS, & IDEAL WORKING CONDITIONS

Submit resume of training & experience to:

The FLUOR CORP.
ENGINEERS-CONSTRUCTORS
2500 S. Atlantic Blvd.
Los Angeles 22, Calif.

Standards Engineer

Attractive opening in Esso Engineering for a Standards Engineer. Will work with a group of engineers preparing engineering standards and standard purchase specifications for oil refinery equipment.

Candidates should be graduate engineers not over 35 years of age. Broad background of at least five years experience with oil refinery equipment desired.

Give full and specific details of education, experience, desired salary, availability date and references.

All inquiries will be considered promptly and held confidential.

Esso Research and Engineering Company
(Formerly Standard Oil Development Company)
Personnel Division
P. O. Box 51 **Linden, N. J.**

Use
THE READER'S SERVICE CARD
For Information Concerning New Equipment and Manufacturers' Literature.

Copies of the 1955 PETROLEUM REFINER Index are still available to subscribers. Use the Reader's Card to send your request.

Jacketing forms around pipe easily. A two man crew can apply jacketing without special installation equipment. Aluminum strapping and seals make application simple and quick, reducing labor costs. Factory-attached moisture barrier is recommended where the presence of moisture could harm aluminum from the under side. The resin type adhesive used exclusively by Childers to bond moisture barrier to under side of jacketing withstands temperatures up to 300°F.

1,286 Plants in 48 States and 14 Foreign Countries

Insure Insulation Efficiency with Childers Jacketing

Leading engineers world-wide specify Childers Jacketing for protecting costly insulation on lines, towers, vessels and tanks. These efficiency minded engineers prefer Childers Jacketing because of these exclusive features:

1. LAP-SEAL (patents pending) insures a more positive weather-seal.
2. Heavy weight jacketing designed for lines subject to abuse.
3. Deep Corrugated Jacketing with factory-attached moisture barrier for towers, vessels and tanks.
4. New resin adhesive that makes a stronger bond between the jacketing and the vapor barrier.

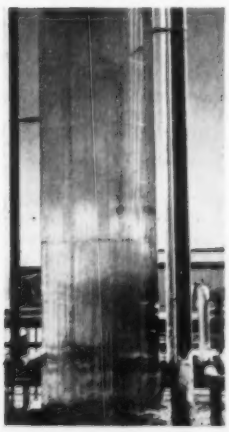
Childers Aluminum Jacketing provides strong, durable protection with three way savings:

1. Lower first cost than any other permanent jacketing.
2. Lower application cost because it's so easy to cut-to-size and attach.
3. Eliminates maintenance because it is made of durable aluminum for maximum corrosion resistance and requires no painting.

Economy minded engineers know that plant efficiency is improved when costly insulation is protected with Childers Aluminum Jacketing. And too, the gleaming beauty of Childers Jacketing makes plants brighter, neater — reduces "housekeeping" costs.

Send for Free Sample and Prices

You can help increase the efficiency of your insulated lines, towers, vessels and tanks by using Childers Jacketing. Write today for free sample and engineering data. Childers Manufacturing Co., Dept. PR-32, Houston 8, Texas.



New Deep Corrugated Jacketing For Towers, Vessels and Tanks

Only Childers offers deep corrugated aluminum jacketing with factory-attached moisture barrier. Available in 1¼" and 2½" corrugations. Childers Deep Corrugated Jacketing is used to provide permanent protection for insulated towers, vessels and tanks.

Heavy Weight Jacketing

Only Childers offers .019" Jacketing in labor saving 4' wide rolls. This exclusive product is recommended to protect insulated lines along walkways and in other areas where they are subject to abuse; also recommended for protection of all insulated towers, vessels and tanks.

Lap-Seal

Childers exclusive LAP-SEAL is a series of eight ribs rolled into the underlapping edge of the jacketing.

Lap-Seal has 2 important advantages:

1. Where desired, a positive weather seal is easily made with Lap-Seal and a mastic.
2. Lap-Seal provides an automatic measure of the 2" circumferential lap. It saves labor, insures proper lap and prevents waste. (Adv.)

What's New in Equipment . . .

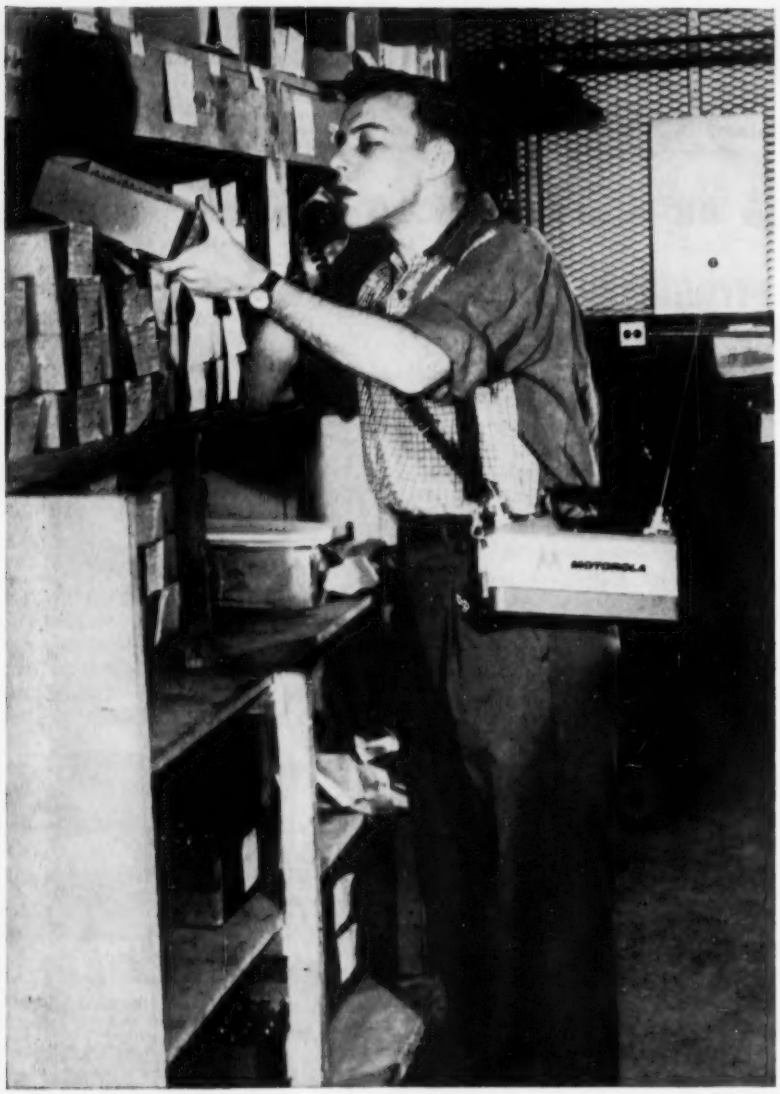
. . . and Manufacturers Literature

Here are two money savers for your plant:

TRANSISTORIZED PORTABLE RADIOS

Two completely new sets of transistorized communication devices have been announced by Motorola. One unit is a portable pocket-sized radio paging system. This unit is used as a paging and message-delivering receiver for individuals over a widespread area. It is controlled from a central receptionist or telephone operator's location by automatic paging equipment. One-way messages can be relayed through this device, and many time-saving locating jobs can be handily accomplished.

The portable receiver itself, using transistors throughout, weighs only 10 oz. and measures only slightly larger than a pack of king size cigarettes. The unit can be clipped in a pocket or worn on a belt by the pagee.



Powered by a 4-volt mercury cell battery, its FM Reception is immune to common types of interference generated by electrical equipment. The battery life is approximately four 40-hour weeks. The unit operating cost is approximately 3 cents per 8-hour work day. Up to several hundred persons per system can be paged individually, the additional channel capacity being added as needed. No FCC license is required for this system because it utilizes the inductive loop method restricted signal radiation.

Also introduced is a new line of transistorized portable radiophones delivering up to 20 times the RF power output conventionally attained in such equipment. The complete line includes models with RF power output ratings from 1 to 8 watts. The lightest and smallest model weighs only 7 pounds, 9 ounces complete. A full 8-watt transmitter power output is realized from a model weighing only 15½ pounds. These units are ideal for two-way communication between vehicles, remote locations in the plant, security forces, and other activities where telephone facilities are unavailable. For additional details, just **circle E1 on the card.**

Mechanical Seals, designed for use on process pumps has been announced by The Garlock Packing Company. These new seals have several distinct features:

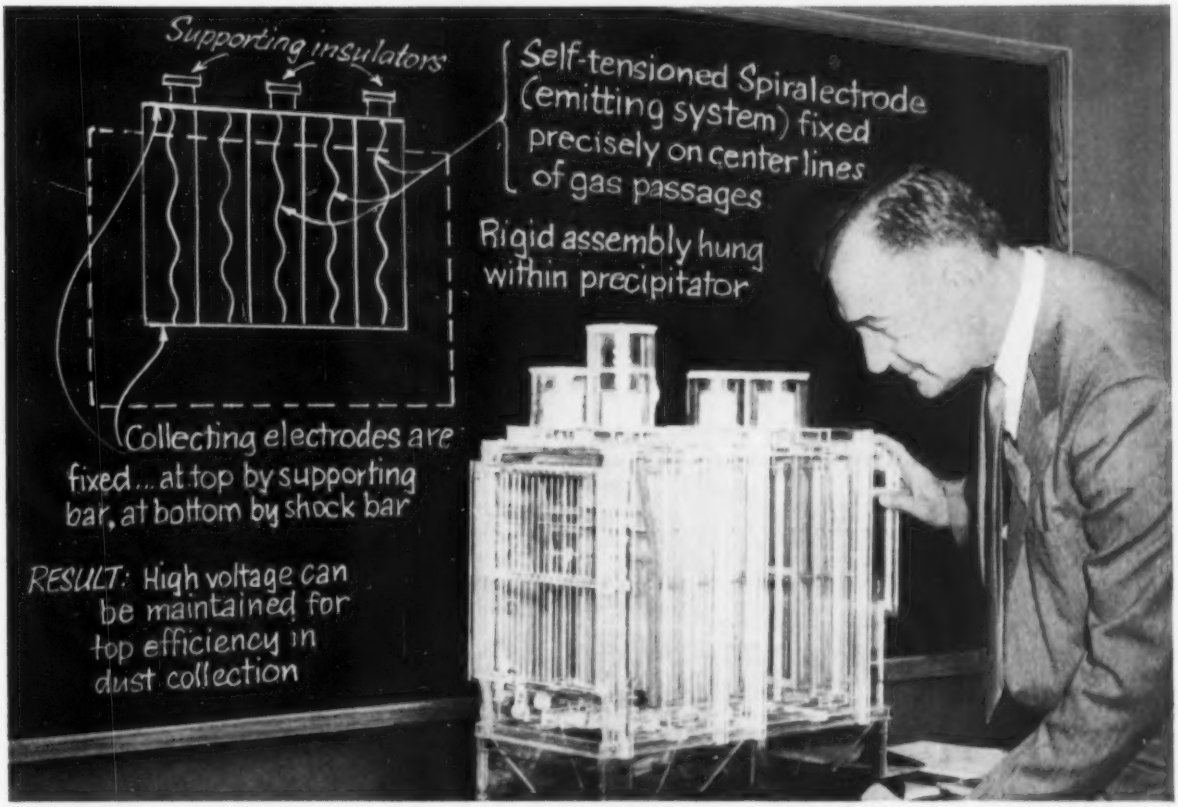
- One-piece assembly: The entire unit, including sleeve and gland, is self contained, ready for quick installation.
- Pre-set at the factory: No on-the-job measurements of adjustments are necessary.
- Collett-Type Drive: No set screws to loosen, corrode or damage shaft or shaft sleeve.
- External lock and drive: Readily accessible.
- Circulating Connections in Glands: Provide cool, clean lubrication to add further life to the seal.

Seals are designed for use on rotary shafts of chemical pumps, oil-refinery pumps and other process pumps.

Complete information, including sectional drawings and diagrams, are contained in Garlock's new 12-page catalog, Bulletin AD-151. Copies are available if you will **circle E2 on the Card.**

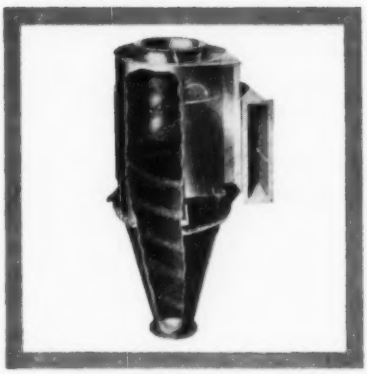
Safety Gauge has been developed by James P. Marsh Corporation. The Marsh Safecase has a solid front to protect the gauge face and a thin stainless steel plate, covering the entire back of the case, to relieve all explosive pressures. The back plate is held firmly to the case by two holding screws, eliminating all possibility of the

How fixed electrodes assure top efficiency in a Buell "SF" Precipitator

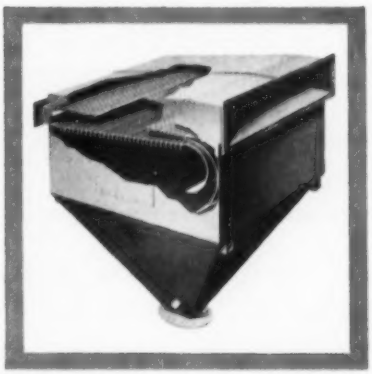

Supporting insulators
Self-tensioned Spiralelectrode (emitting system) fixed precisely on center lines of gas passages
Rigid assembly hung within precipitator
Collecting electrodes are fixed... at top by supporting bar, at bottom by shock bar
RESULT: High voltage can be maintained for top efficiency in dust collection

PHOTOGRAPH OF BUELL PLASTIC MODEL BY INDUSTRY & POWER

Even when high-resistivity dusts must be collected, top efficiency is guaranteed by the exclusive shape of Buell's Spiralectrodes—proved to give 50-100% greater emission than straight wires. Exclusive Continuous Cycle Rapping virtually eliminates maintenance by keeping electrodes constantly clean.



Buell Cyclones also assure top efficiency with large diameter design to eliminate clogging . . . and by harnessing double-eddy and putting it to work.



Buell's Low Resistance Fly Ash Collector combines top efficiency to meet present strictness, with low draft loss for natural or mechanical installations.

GET ALL THE FACTS

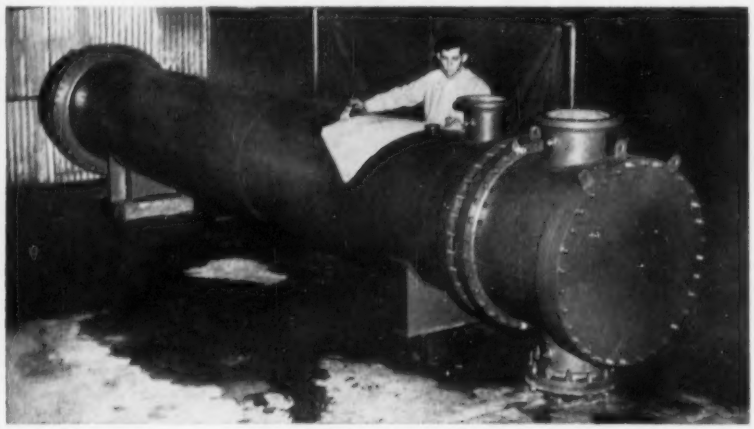
Write to:
Buell Engineering Company,
Dept. 21-C, 70 Pine Street,
New York 5, New York

buell®

MECHANICAL ELECTRICAL

Experts at delivering Extra Efficiency in **DUST COLLECTION SYSTEMS**

(Advertisement)



Final Checkout . . .

. . . Only 5 weeks from initial order.

Just 5 weeks after initial order, a KEMCO inspector confirms all specifications on a 4,000 sq. ft. heat exchanger designed and constructed by Krueger Engineering and Manufacturing Company for a major gulf coast petrochemical company.

If your problem is getting heat exchangers fast enough to meet production deadline, KEMCO can give you this same fast service—faster than any other company.

Get in touch with KEMCO at P. O. Box 1644, Houston 1, Texas. They're the industry's fastest.

Petrochemical Handbook Reprint

Now available in reprint form, the Petrochemical Handbook Section of PETROLEUM REFINER'S December, 1955, issue contains graphic data on:

80 manufacturing processes
10 separation processes
. . . of the most interesting Petrochemicals

Here's your chance to add to your library the latest job help information on petrochemicals. Available for only $1.00 per copy, you may obtain this reprint by addressing:

REPRINT DEPARTMENT

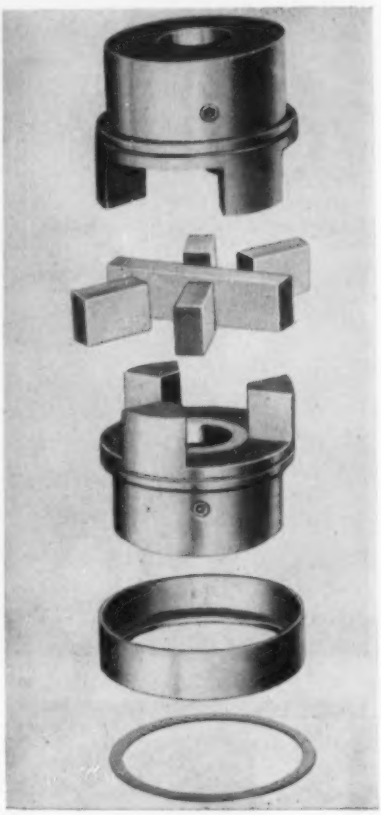
PETROLEUM REFINER

P. O. BOX 2608, HOUSTON 1, TEXAS

New Equipment . . .

back plate becoming detached in the event of a blow-out.

This new gauge provides a high degree of safety in the industrial plant and minimizes possibility of shattered glass in the case of an internal tube failure in the gauge. For additional information, just **circle E3 on the card.**



Radially Removable Flexible Coupling has been announced by Lovejoy Flexible Coupling Company. The unit is lubrication free and is suited to coupling of drivers, centrifugal pumps or other similar installations where radial removability is desirable.

This coupling is available in six sizes, ranging from 2.58 to 29.6 hp at 100 rpm.

Radial removability is accomplished by special cushions cut so they are held in position by standard Type "C" collar when the coupling is assembled. The unit is called the C-R and has other features previously available in the Lovejoy Type C coupling. For complete information, just **circle E4 on the card.**

New Instrument Data has been published by Minneapolis-Honeywell Regulator Company, Industrial Division. Bulletin 7202 describes the new Honeywell Tel-O-Set vertical scale indicator. Up to date information on the Tel-O-Set recorders and controllers is also included.

These miniature instruments are used to measure and control process variables such as temperature, pressure, flow, and liquid

San Pedro Terminal stores Natural Gasoline . . .

Two 141½-ft. diam. Hortonspheroids at the Warren Petroleum Corporation San Pedro terminal.

in Hortonspheroids . . .

Natural gasoline, at the Warren Petroleum Corporation's San Pedro, Cal., terminal, is stored in the two 141½-ft. diam. Hortonspheroids® shown above, to prevent excessive evaporation loss. The structures, designed for 15 lbs. per sq. in. working pressure will allow no loss to occur as long as the internal pressure does not exceed the pressure relief valve settings.

CB&I builds Hortonspheroids in standard capacities to 120,000 bbls. and in the smaller capacities for pressure to 100 lbs. per sq. in. Our nearest office will be happy to supply further information.

Office of the terminal with the Hortonspheroids in the background.

CBI

Chicago Bridge & Iron Company

Atlanta • Birmingham • Boston • Chicago • Cleveland • Detroit • Houston
Los Angeles • New York • Philadelphia • Pittsburgh • Salt Lake City
San Francisco • Seattle • Tulsa

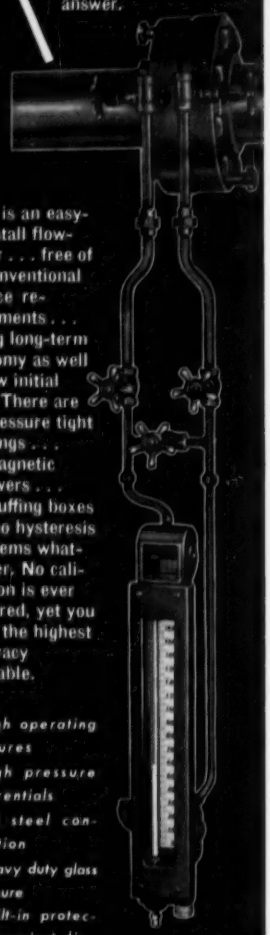
Plants In BIRMINGHAM, CHICAGO, SALT LAKE CITY and GREENVILLE, PA.

For more data on advertised products, use Readers' Service Cards, last page.

UNMATCHED ACCURACY

in direct flow indication

Wherever you seek simplicity and high accuracy in flow measurement at lowest cost, the Meriam "H" Meter is the well-known answer.



Here is an easy-to-install flowmeter . . . free of all conventional service requirements . . . giving long-term economy as well as low initial cost. There are no pressure tight bearings . . . no magnetic followers . . . no stuffing boxes . . . no hysteresis problems whatsoever. No calibration is ever required, yet you have the highest accuracy available.

★ High operating pressures
★ High pressure differentials
★ All steel construction
★ Heavy duty glass enclosure
★ Built-in protection against line surges

Write for Bulletin 18A

Meriam Manometer Instrumentation
...for pressures, vacuums, flows, liquid levels.

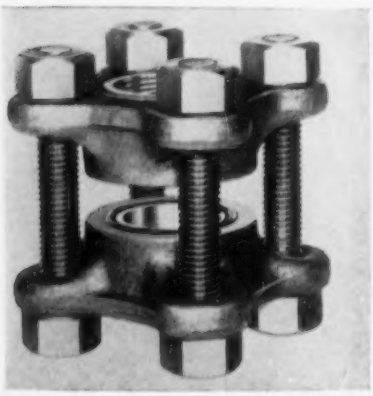
meriam
INSTRUMENT COMPANY
10920 Madison Ave. • Cleveland 2, Ohio

New Equipment . . .

level. Specification Sheet 248 describes Differential Converter mercuryless and liquid level transmitter, with non-bleed pilot relay.

These operate on a neumatic-balance principle, and transmit readings to receiving instruments at distances as great as 1000 feet from the point of measuring. Bulletin 7040 describes the new Honeywell small-case Indicating Pressure Controller. This is available in ranges from 0 to 50 to 0 to 200 psi, with on-off or 10% Throttlor control.

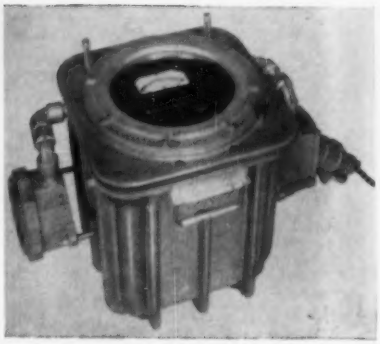
The case matches that of the small-case temperature controller. Specification Sheet 242-2 describes mechanical flow meters with evenly graduated charts and scales. The meter body, which is a characterized bell float, is mounted integrally with the measuring instrument, forming a self-contained measuring system for pipe stand or panel mounting close to the point of measurement. For your copy of these new publications, just **circle E5 on the card.**



O-Ring Flange Unions are now available from Watson-Stillman Fittings Division, H. K. Porter Company, Inc. Included in this line are two-and four-bolt flange unions with O-Ring seals. Flanges are of forged steel and are furnished with high tensile studs. The unions are available in the 3000-pound class in both threaded and socket weld types. Sizes ¼-inch and 1¼-inch are two-bolt, and sizes 1-inch to 2-inch are four-bolt. The O-Rings are available in a variety of precision-molded materials to resist a wide range of service conditions. For complete details on this new type fittings, just **circle E6 on the card.**

Insulation Protective Coating is described in a new eight-page, two-color, illustrated bulleting issued by the American Bitumuls and Asphalt Company. The booklet describes Laykold Weathercoat, a cold-applied asphaltic composition, which provides a durable protective coating on all types of thermal insulation such as that used in refineries and petrochemical plants.

The product is described as being compounded from selected asphalts, with a high resistance to moisture in all forms, both liquid and vapor. The bulletin includes photographs of typical installation methods and technical data. For your copy of this bulletin, just **circle E7 on the card.**



Portable Gas Alarm is available in a new self-contained continuous sampling unit developed by Davis Instruments, Division of Davis Emergency Equipment Company, Inc.

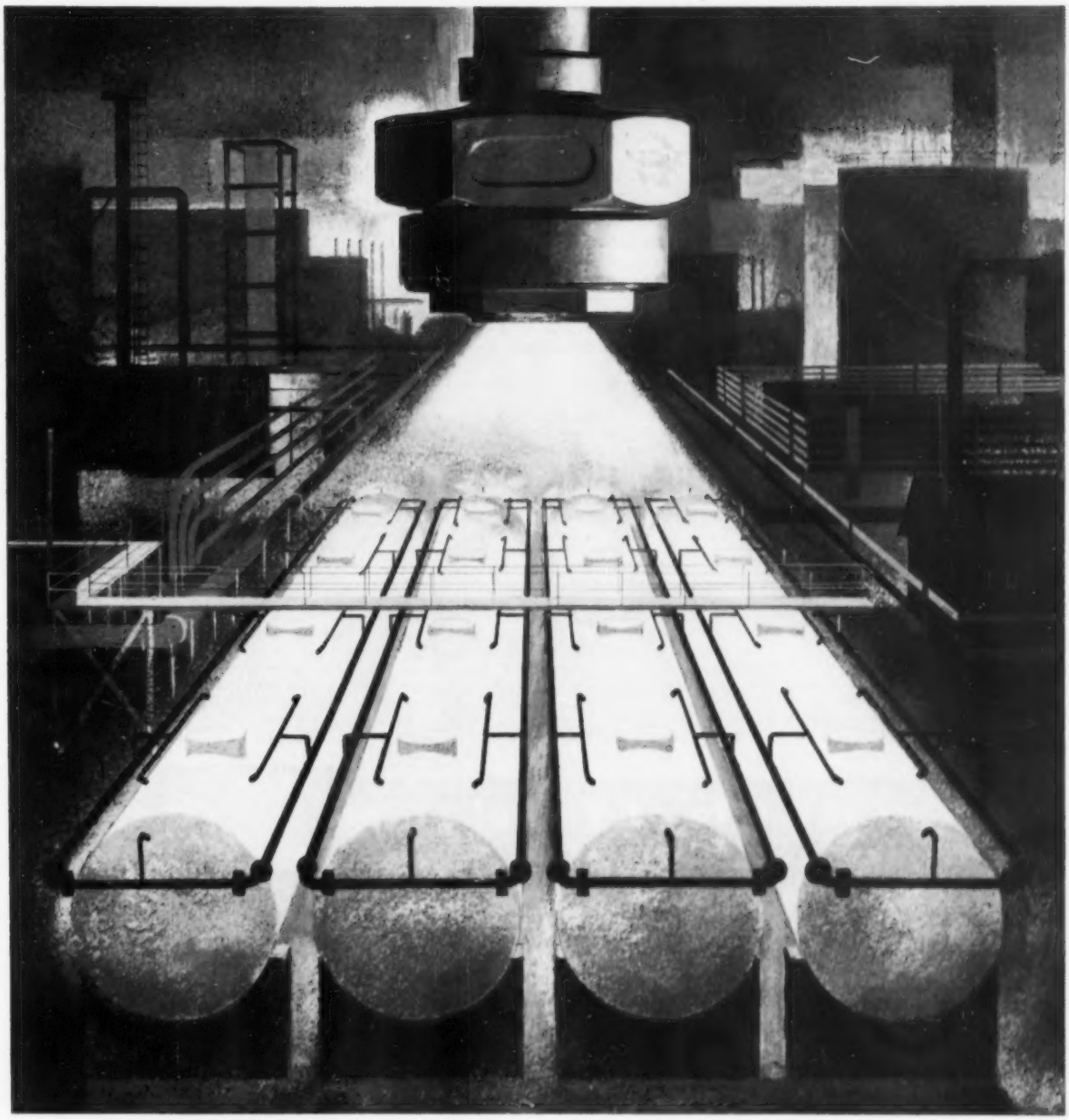
The unit is designed for use in or near hazardous locations and has a continuous campling system operated by a motor-driven pump mounted inside the unit. Among various features are visual and audible high gas signals, large and readily visible meter calibrated 0 to lower explosive limit, showing gas or vapor concentration at all times.

Also, there is a built-in trouble indicating circuit with indicating lights and an audible signal. For additional information, just **circle E8 on the card.**

Partition Chromatography by a new instrument which makes an automatic quantitative and qualitative analysis of gases and volatile liquids is performed by the Fisher-Gulf Partitioner. This new automatic unit has been announced by Fisher Scientific Company.

A unique built-in integrator simultaneously computes and records a number proportional to the quantity of the component indicated. The instrument was developed for analysis of petroleum and petrochemicals by specialists in the Gulf Research and Development Company and in Fisher Scientific's own Research and Development Laboratories.

The Partitioner uses very small samples —0.01-0.03 ml. of liquid or 0.3-0.6 ml. of gas. It makes a full analysis of a multicomponent system in minutes, where distillation could take hours or days. It has a



give your plant and equipment the best fire protection— a BLAW-KNOX automatic fog system

BLAW-KNOX Automatic Fire Protection Systems are engineered to provide positive protection for your plant and processing, storage, and other equipment. If a fire breaks out, the system goes into action immediately:

- **alarms sound**
- **fire smothered *promptly***
- **heat dissipated by *cooling* action**
- **pressure build-up prevented**

Why not give your plant and equipment the BEST possible protection. Let a Blaw-Knox *fire-protection* Engineer study your needs. He will gladly submit a layout and a cost estimate . . . with no obligation to you.

"Little Joey Sprinkler always on the job"

BLAW-KNOX

BLAW-KNOX COMPANY
Automatic Sprinkler Department
Pittsburgh 33, Pennsylvania

For more data on advertised products, use Readers' Service Cards, last page.

New Equipment . . .

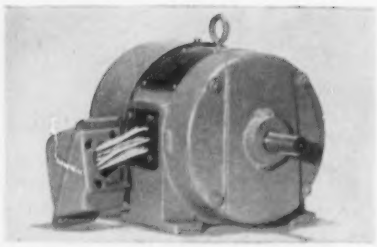
resolving power equivalent to a distillation column with more than 1000 theoretical plates.

The instrument is available with several types of prepacked columns. The Partitioner columns do not have to be removed and reconditioned between runs. One unit has been in continuous industrial use for more than a year with no deterioration. A new sample can be injected as soon as the previous one has passed through the column. For additional information on this unique device, just **circle E9 on the card.**

Steel Tubes . . . The tubular products division of Babcock & Wilcox Company have published two new bulletins TB-357, TB-408 on their products. The first is technical information on tubular products intended for sub-temperature applications. It is a six-page bulletin complete in most detail.

The second bulletin contains a complete listing of the type of tubing produced and a brief description of the technical literature available on such specific types of tubular products as stainless and alloy tubing, stainless pipe, and heat exchanger and condenser tubing, boiler tubing and mechanical tubing. Also, the pamphlet contains a table of chemical analyses, physical properties, mechanical properties, and creep strength of twenty steels ranging from carbon steel through the stainless steels which are used by the process industries.

For your copies of these useful bulletins, **circle E10 on the card.**



Small Electrical Motors in the one-to five-horsepower range have been announced in a new line of enclosed non-ventilated, fan-cooled motors. General Electric Company's Small Integral Motor Department announces the new AC lines designated as Standard Enclosed and Severe Duty Enclosed.

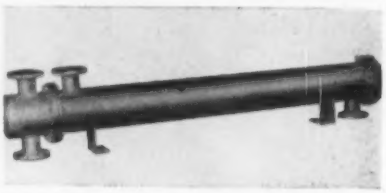
These two lines replace a single line of one-through five-horsepower motor. The Standard Enclosed motor features a steel conduit box and fan cover. The conduit box has keyhole mounting for quick and easy installation. Mounting screws need not be removed. The fan cover of steel is lighter and more rugged and easier to realign on reassembly. Cast iron, for rigidity, is retained on the rest of the enclosure.

The Severe Duty line is basically the same as the Standard line except for certain features which make the severe duty motor suitable for use in corrosive or excessively moist atmospheres.

All threaded parts are coated with a special lubricant to prevent threads from seizing. Neoprene-sealed washers on the through bolts and a new type shaft seal also give additional moisture protection. The conduit box and fan cover are of cast iron for greater corrosion resistance. A special stainless steel hardware kit is available for special corrosive applications. For additional information, **just circle E11 on the card.**

This item supplements General Electric Company data on pages 442-443 of The Refinery Catalog, 23rd Edition.

Extreme Service Lubricants and Greases are covered in a new two-colored catalog published by Jet-Lube Incorporated. This four-page bulletin contains complete information on Jet-Lube Multi-Purpose greases, Outside Gear and Track Roller Lubricants, MX Gear Oils with Moly-Disulphide, Chain and Gear Oil, Kopr-Kote Anti-Seize Compound, Thick-or-Thin Sealing Compound, and Moly-Spray Air-Dry Lubricant. For your copy of this extreme lubricant data, just **circle E12 on the card.**



New Standard Exchangers in sizes from 20 to 400 square feet of surface are available from stock from Struthers Wells Corporation. The standardization and design of components make the units relatively low cost. Several exchanger arrangements are available in this standard line,

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identifies metal in Spirotallic® Gaskets

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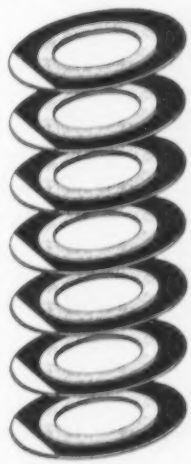
Because so many of these metals look alike, only expensive tests or costly experience with the gasket could determine the gasket metal used, once its identifying tag was lost. Now the color patch on the centering guide tells the metal employed and saves time, trouble and expense. This new method of identification also makes it easier for storekeepers and mechanics who handle the gasket. In addition, it simplifies inventories.

Spirotallic Gaskets hold their seal because they are made of spirally wound interlocking plies of asbestos and spring-like metal strip. These gaskets compress easily with light bolting. For catalog PK-35A and copy of color code card write Johns-Manville, Box 60, New York 16, N. Y. In Canada, Port Credit, Ont.

Here are seven of the metals available and their color identifications



Zinc-coated steel—white

Type 304 Stainless—yellow

Type 316 Stainless—green

Type 347 Stainless—blue

Monel—orange

Copper—brown

Aluminum—aluminum

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Johns-Manville SPIROTALLIC GASKETS

New Equipment . . .

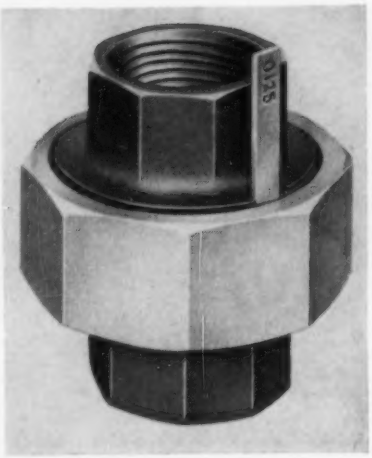
including fixed tube sheet, floating head and U-tube units.

The units are available in single and multi-pass tube arrangements. Materials of construction include carbon steel, non-ferrous alloy and stainless alloys Types 304 and 316. The units are constructed in accordance with the ASME Code and TEMA Class A. Details on these units may be obtained by just circling **E13 on the card.**

Epoxidation-Hydroxylation Bulletin is available from Becco Chemical Division, Food Machinery and Chemical Corporation. The 49-page bulletin fully describes reactions of unsaturated olefins (aliphatic and alicyclic) derived from agricultural products and the petroleum industry, including unsaturated fatty acids and their esters, alcohols, fats and oils, terpenes, polymers, and monomers.

One of the important features of the bulletin is a nine-page conversion table for rapid calculation of moles of ethylenic unsaturation in a raw material of a given iodine or bromine number; oxidant requirements for the epoxidation or hydroxylation of said raw material; and percent of oxirane oxygen or hydroxyl in the resultant product.

Other pages are devoted to advantages of hydrogen peroxide or peracids and oxidants in organic synthesis; safety considerations; process equipment; and uses of epoxy and dihydroxy compounds. For your copy of this comprehensive, technical bulletin, just **circle E14 on the card.**



Tab Orifice Union . . . The Watson-Stillman Fittings Division of H. K. Porter Company, Inc., has added to its line of forged steel fittings a 3000 pound Tab Orifice Union for instrumentation and process control piping. This union eliminates errors in orifice plate identification. The orifice size is plainly stamped on a tab that protrudes through a slot in the end piece of the union. The tab is an integral part of the stainless steel orifice plate. A bulletin is available containing sizes, dimensions and price information. For your copy of data sheet SU-1, **circle E15 on the card.**

This item supplements Crane Company data on page 887 of The Refinery Catalog, 22nd Edition.

Ucon Synthetic Fluids are covered in complete detail in a new 52-page booklet published by Carbide and Carbon Chemicals Company, a division of Union Carbide and Carbon Corporation. The booklet covers properties, applications, and characteristics of these polyalkylene-glycol derivatives.

Ucon fluids and lubricants have a multitude of established uses as mechanical lubricants, hydraulic fluids, rubber and textile lubricants, heat-transfer fluids, antifoam agents, solvents, and formulation compoents. They are supplied in both water-soluble and water-insoluble series—with or without additives.

Viscosities range from 50 to between 60,000 and 90,000 Saybolt Universal Seconds at 100° Fahrenheit. Their physical characteristics are different from those of animal, vegetable, and mineral oils.

They have high viscosity indexes, low pour points, and excellent lubricity. They are wax-free, non-carbonizing, sludge resistant, and non-corrosive to metals. They have little or no effect on rubber. For your copy of this technical data, **circle E16 on the card.**

Solonoid Valves . . . Barksdale Valves have published a new catalog 5-C on solonoid valves of several types. Included are valve characteristics, flow patterns, overall dimension, photographs and ordering data. For your copy of this data, just **circle E17 on the card.**

High Pressure Meters are covered in an eight-page bulletin just published by the Granberg Corporation. Included in this brochure is a complete description of all three types of Granco high pressure

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GHH Maulwurf pumps are high pressure centrifugal gas circulators especially designed for application in the chemical industry to increase the pressure of the nitrogen-hydrogen mixture in ammonia synthesis.

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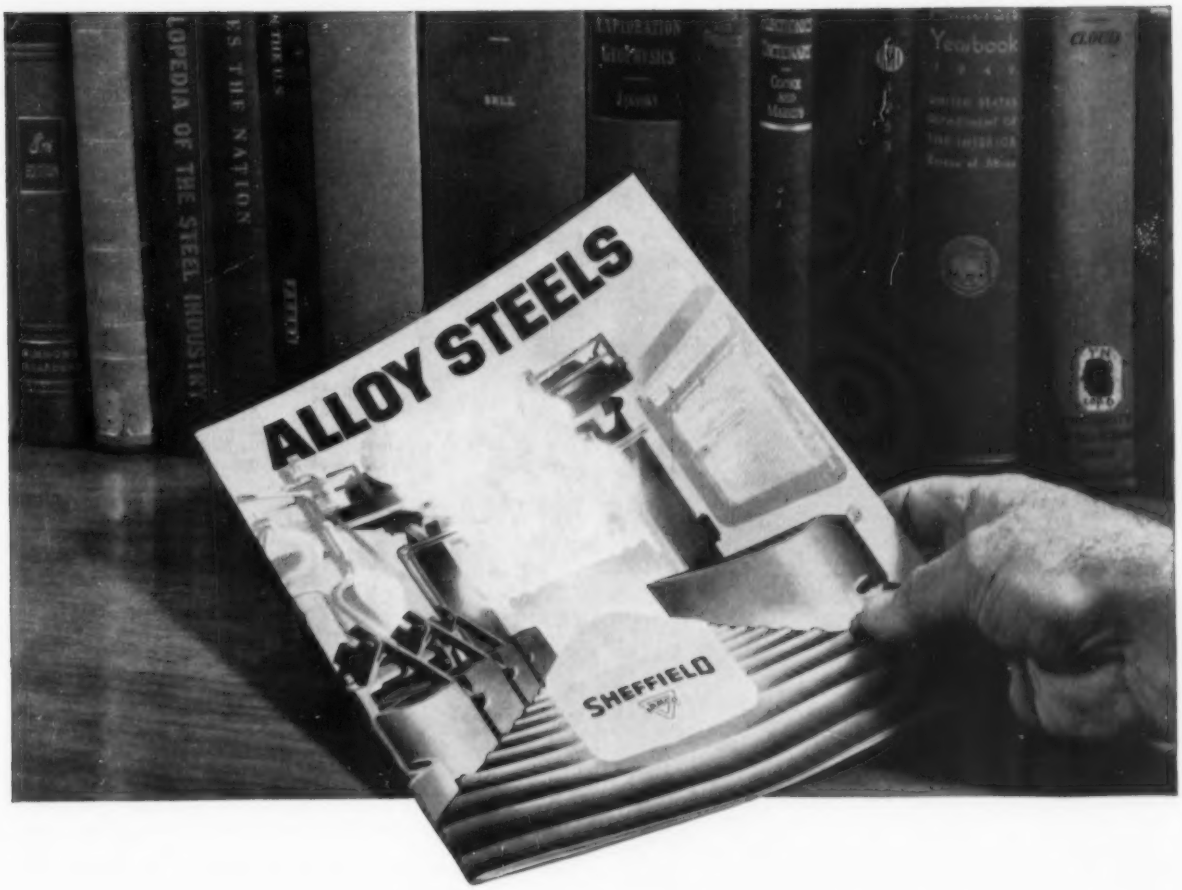

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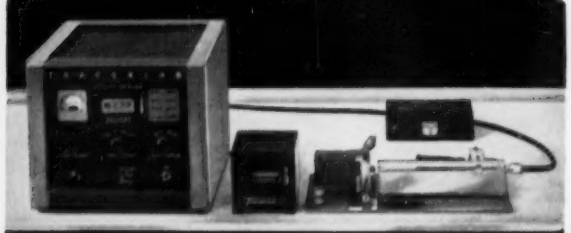
determination of sulphur in hydrocarbons



Tracerlab's sulphur determination apparatus enables you to use the fastest method to determine accurately the sulphur content of hydrocarbons such as fuel oil and gasoline. With this new Tracerlab equipment, unskilled operators can determine sulphur content quickly, easily, precisely. Hence, sulphur determination can now be put on a wholly routine basis.

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meters: positive displacement; double-case; and the latest model, the Granco Duo-Rotor meter.

Capacities of these high pressure meters go up as high as 30,000 GPM. The new booklet contains metering principles, dimensions and specifications, engineering data and pressure-drop charts for all three models. Also included are Granco high pressure meter accessories, such as: strainers; air eliminators; and remote control units. For your copy of this bulletin, just **circle E18 on the card.**

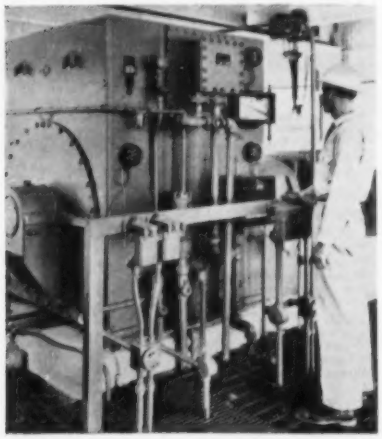
Electro-Pneumatic Controllers . . . Complete information about L&N's new "Speedomax" H electro-pneumatic controllers—current-adjusting type—is now available in a 4-page data sheet just published by Leeds & Northrup Company. This new sheet describes how this control system combines the advantages of pneumatic control with the flexibility and fast response of an electrical system.

Included in the sheet is a full description, complete with line drawings and photographs, of the Speedomax H electro-pneumatic controller and its associated converter. Specifications and standard ranges for all models are conveniently tabulated along with equipment for the complete control system. "Ordering Instructions" complete the sheet. **Circle E19 on the card.**

Inert Gas Filled electrical motors are being manufactured by the Electric Machinery Manufacturing Company. The motors were designed and built for maximum protection against explosion of hydrogen and other hazardous material frequently encountered in process plants.

The motor is cooled by circulation of the inert gas through a water cooler mounted near the top of enclosure. A slight positive pressure is maintained within the motor enclosure at all times so that any leakage is exfiltration of inert gas rather than infiltration of combustible vapors.

The motor is complete with safety features, including inert gas pressure and temperature gages, relays with alarms and shutdown contacts, indicators for oil feed to bearings, oil level sight gages on oil reservoir and bearing housing, and purge valves for start up. For additional information on these special purpose units, just **circle E20 on the card.**



New Electronic Unit Applied To Various Data-Handling Jobs

A New Electronic Data-Handling System has been announced by the Beckman division of Beckman Instruments, Inc. Versatility is achieved through the use of the pinboard programmer by which the system can be applied to a variety of processes and permits quick adaptation of the system to changes in the specific data-handling requirements.

Easy digital control over the many system functions, such as scaling, zero offset, linearizing, alarm limits, totalizing, and readout, is accomplished through the programmer. An analog-to-digital converter performs the mathematical functions necessary to transform the electrical measurements into numerical form. A system strong point is its accuracy.

Over-all system accuracy is .10 percent of the value being read and not necessarily of full scale. Large voltages are continually checked against a standard cell and the analog-to-digital converted eliminates all ambiguity.

Performance data from the system is logged out in paper tape, punched cards, or on automatic typewriters. Two typewriters are provided with the system. One for logging and the other for alarm. For additional detailed information on this new data-handling systems, just **circle E21 on the card.**

Construction and Operational Details of a new induced-draft cooling tower are described in a special bulletin, C. T. CT-56-1, published by Foster Wheeler Corporation. In addition to a three-dimensional wash drawing of a tower cell, the two-color, four-page, publication also includes perspective drawings of major equipment features.

These include water-mixer drift eliminators, full cone spray nozzles, double diamond fill racks, double lapped sheathing panels, bracing and anchoring system and all-redwood framing. Materials of construction and operational features are covered in accompanying text.

Copies of the bulletin may be had by **circling E22 on the card.**

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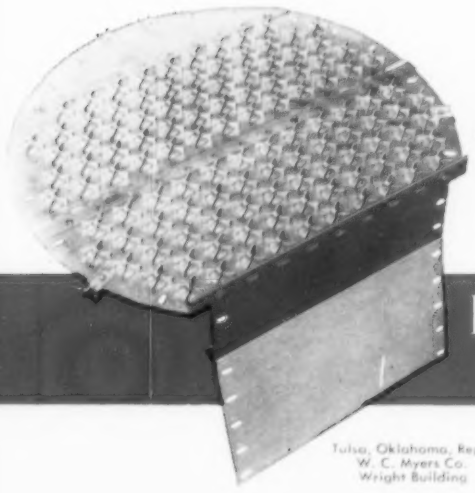

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